INSTRUCTION MANUAL

FOR

DCR 600-18A

Sorensen
POWER SUPPLIES

GENERAL ELECTRIC
INSTRUMENTATION & COMMUNICATIONS
1200 KONA DRIVE
COMPTON, CA 90220
(213) 642-5317

RAYTHEON

RAYTHEON COMPANY

676 ISLAND POND ROAD

MANCHESTER , NEW HAMPSHIRE 03103

U.S.A.

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RAYTHEON COMPANY, Sorensen Operation

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SECTION I

INTRODUCTION AND DESCRIPTION

1-1 INTRODUCTION

1-2. This manual contains operation and maintenance data on the Model 600-18A, three-phase input power supply, manufactured by Raytheon Company, Sorensen Power Supplies, Manchester, New Hampshire. It is intended to familiarize the user with the functioning of the unit, to introduce the varied applications for which the unit may be adapted and to furnish sufficient maintenance data to assure long operating life.

1-3. Eight sections comprise the major subdivisions. This introduction and a general description of the unit and its applications, along with complete unit specifications and performance curves, form Section I. Section II delineates procedures to be followed when the unit arrives at destination. It also contains procedures for adapting the unit to its alternate input voltages. A tabular listing of front-panel indicators and controls, and a functional description of each item completes Section III. Operating instructions, including procedures for adapting the unit to a number of varied applications, are outlined in Section IV. Section V provides the principles of operation. Details on troubleshooting, repair and calibration of the unit are furnished in Section VI. An illustrated replacement parts list forms Section VII. Overvoltage protector optional accessory is in Section VIII.

1-4. DESCRIPTION.

1-5. Designed for either rack or floor mounting, the DCR provides a stable, highly regulated dc output from a wide range of three-phase input voltages and frequencies. Voltage and current ranges are 0-600 V and 0-18A, at 55°C (131°F), respectively. (For complete unit specifications, refer to Table 1-1). The unit exhibits excellent transient response as well as low ripple in both the voltage-regulating and current-limiting modes. Turn-off and turn-on overshoots above 60 V (output setting) are non-existent and below this voltage are only 8 V.

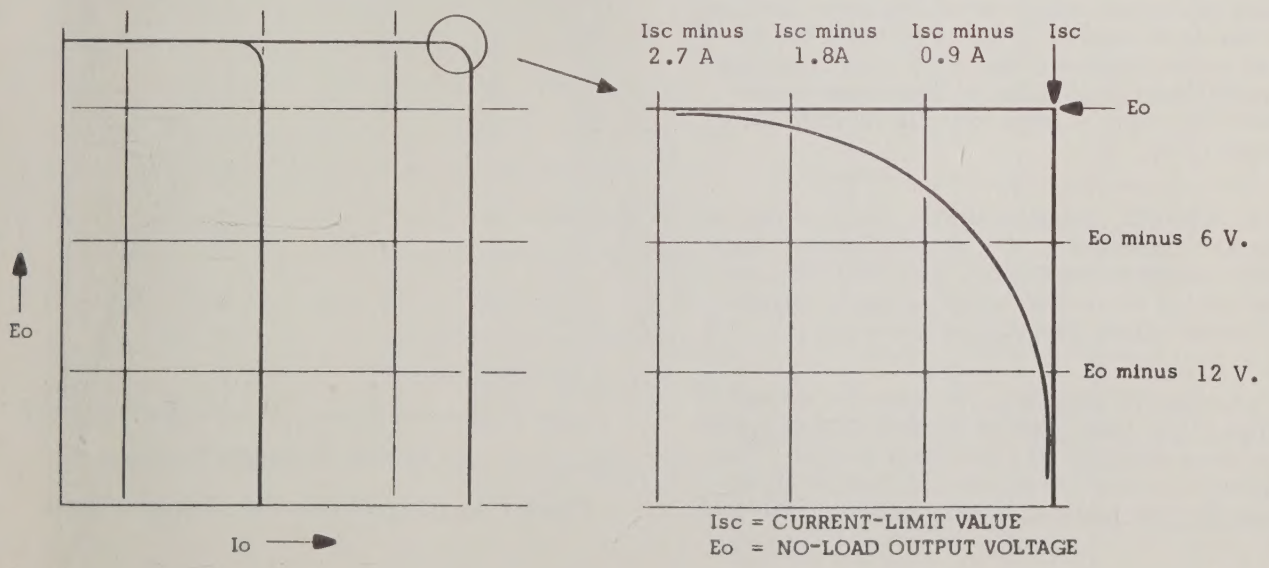


Figure 1-1. Crossover Characteristics

1-6. Other designed-in features include provisions for adapting the unit for remote programming, remote sensing and parallel operation. Increased versatility is also obtained by the floating neutral, which permits either a three- or four wire input.

1-7. AUTOMATIC CROSSOVER. The automatic-crossover system allows the unit to transfer operating modes as a function of load requirements. If, for example, current output is set for 3.6 A and the load requirements are greater than this value, the unit will transfer operation automatically from voltage regulating to the current-limiting mode. In this mode, the current will be held to the 3.6 A selected output. If load requirements are lowered or if the current-limiting value is raised through the front panel-mounted current adjust control, transfer to the voltage-regulating mode will occur automatically.

1-8. In the crossover transfer region, voltage- and current-mode regulation deteriorates as shown in Figure 1-1. For example, with the current-limit value set at 3.6 amps, the voltage-mode regulation begins to deteriorate when the load current exceeds 1.8 amps. This occurs at the point labeled I_{SC} minus 1.8 A, or in this example 3.6 amps minus 1.8 amps. The current-mode regulation begins to deteriorate at the point in the curve labeled E_O minus 12 V. If the no load output voltage is set to 24 volts, then the current-mode regulation begins to deteriorate when the output voltage exceeds 12 volts (24 V minus 12 V).

1-9. REMOTE PROGRAMMING. The unit may be remote programmed in any of three modes, voltage, current or resistance. This feature permits the user to adjust the output voltage or current to preset values from remote locations.

1-10. REMOTE SENSING. To allow for voltage drops in the load lines, a remote-sensing system has been designed into the power supply. This system monitors the unit output voltage to assure that the selected voltage is being delivered to the load and not simply across the unit's output terminals. The maximum drop for which the unit will compensate is 3 V per line.

1-11. PARALLEL OPERATION. Parallel operation permits the unit to be used in applications where output requirements are above those for which the unit is designed. As many units as desired may be placed in parallel. However, some loss of regulation will be incurred for each unit (refer to para 4-32).

1-12. FAILURE PROTECTION. In addition to the current-limiting protection provided by automatic crossover and the current regulator, the unit incorporates two other protection systems. One drops the unit output to zero and energizes a light on the control panel if there is a loss of one input phase. The other, thermal overload usually resulting from a cooling-fan failure, will also drop the output, and a failure indicator on the panel will glow.

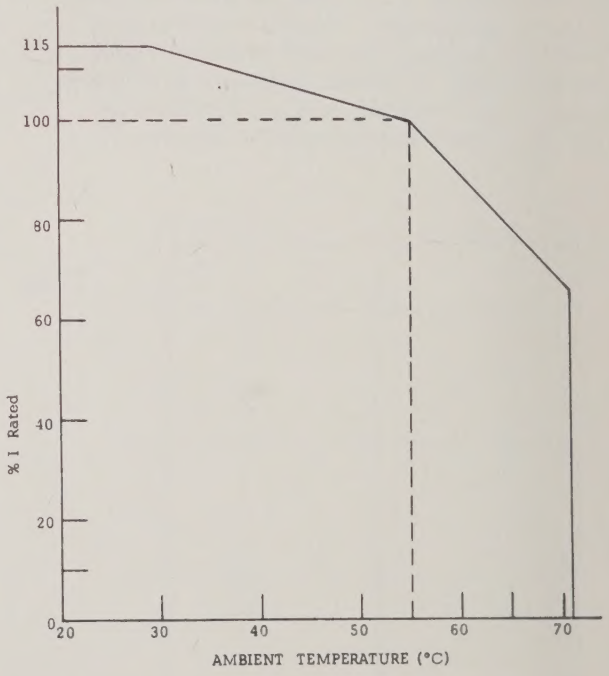


Figure 1-2. Current Derating Characteristics

1-13. OPTIONAL EQUIPMENT.

1-14. REAR SUPPORT KIT. This kit is comprised of two angle brackets which, when rack-mounting a unit, are installed on the vertical members of the rack to guarantee adequate support. Refer to Table 1-2 for additional data.

1-15. CASTER KIT. This optional item, when installed, allows the unit to be moved easily from place-to-place. It consists of four swivel-type casters, two of which have braking mechanisms.

1-16. COVER KIT. A kit designed to add to the decorative appearance of the unit is offered as an accessory. It includes two side covers and the required attaching hardware.

1-17. OVERVOLTAGE PROTECTOR. The overvoltage protector, factory installed, prevents damage to the load by automatically dropping the output at a preselected maximum voltage.

ITEM	PART NO.	DESCRIPTION
Support Kit	190-3674	Heavy-duty angle brackets to help support rack mounted units.
Caster Kit	190-3676	Four casters to give unit mobility. Two support brackets. 16 screws and washers.
Cover Kit	190-3678	Two side covers for decorative purposes. 12 screws.
Overvoltage Protector	VP-22	See Section VIII

Table 1-2. Optional Equipment

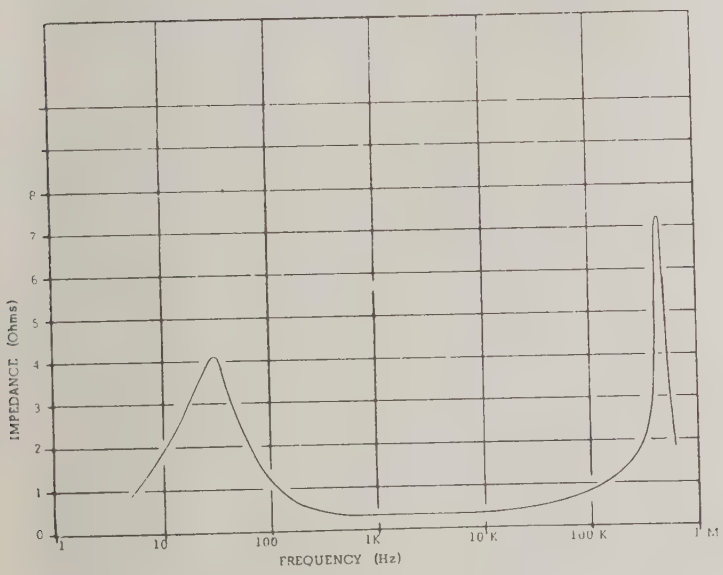


Figure 1-3. Typical Output Impedance (Semilog Plot)

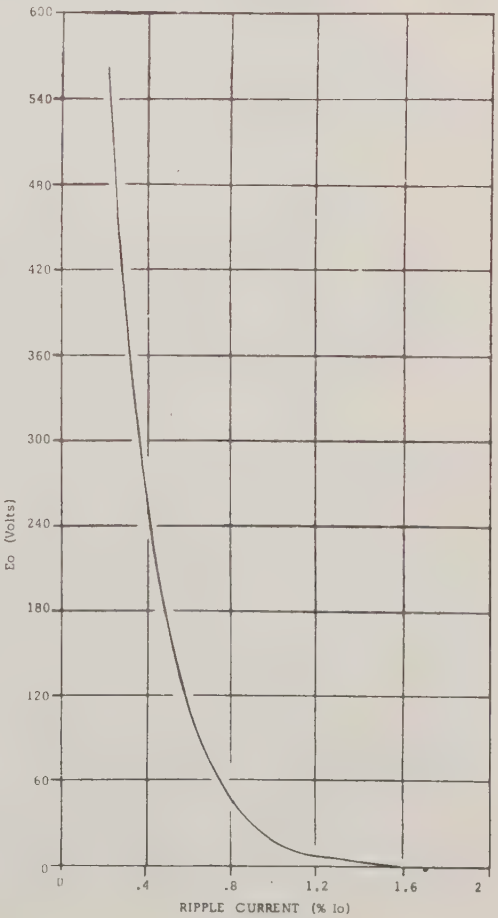


Figure 1-4.
Ripple Current Vs. Output Voltage

MODEL DCR 600-18A		
INPUT RATINGS:		
Voltage Range	187-229/207-253/342-418/ 390-440/414-506	Vac
Frequency	50 - 63 (1)	Hz
Phase	3	
Current at 208 Vac	60	A max.
at 230 Vac	54	A max.
at 380, 415, or 460 Vac	27	A max.
Power Factor(2) (typical)	0.68	
Efficiency(2) (typical)	81	%
OUTPUT RATINGS:		
Voltage Regulation Mode		
Voltage Range (3)	0 - 600	Vdc
Coarse Voltage Adjust Range (4)	0 - 600	Vdc
Fine Voltage Adjust Range	0 - 30	Vdc
Resolution (typical)	300	mV
Current Range at 40°C	0 - 19.8	Adc
55°C	0 - 18.0	Adc
71°C	0 - 12.0	Adc
Current Regulation Mode		
Current Range	See Above	
Typical Resolution	90	mA
Dynamic Voltage Range (5)	0 - 560 (6)	Vdc
Current Voltage Crossover	See Figure 1-1.	
REGULATION:		
Output Voltage Regulation for combined line and load	±0.10% or ± 120 mV whichever is greater	
Output Current Regulation for combined line and load (full dynamic voltage change) with voltage control set to 600 V.	± 36 mA	
RIPPLE:		
Voltage Regulation Mode		
Max. RMS Ripple Voltage	800 mV +0.4% E_o or 2 V, whichever is less	
Typical Peak-to-Peak less than	4 V	
Current Regulation Mode		
Typical RMS Ripple Current	See Figure 1-4	
TRANSIENT RESPONSE: (for a step load change of 1/2 load to full load or full load to 1/2 load)		
Typical Output Voltage Deviation	42 V	
Typical Recovery to Within ± 1% of Band	40 msec	
TEMPERATURE COEFFICIENT:		
Output Voltage, Voltage Mode	240 mV/°C (typ)	
Output Current, Current Mode	36 mA/°C (typ)	

Table 1-1. Unit Specifications (Sheet 1 of 2)

MODEL DCR 600-18A	
OUTPUT VOLTAGE OVERSHOOT	
Turn Off	None above 60 V 8 V below 60 V (typ)
Turn On	None above 60 V 8 V below 60 V (typ)
AMBIENT TEMPERATURE RANGE:	0 - 71°C (See Figure 1-2 for Current Derating Curve)
REMOTE PROGRAMMING:	
Voltage Mode(7)	5 ohm/volt (typ)
Current Mode	8.3 ohm/amp (typ)
OUTPUT IMPEDANCE:	See Figure 1-3
STABILITY:	
8 Hr. after Warm-Up; Voltage Mode	1.6 V (typ)
Current Mode	0.09 A (typ)
REMOTE SENSING:	Max. 3 V drop in each leg
COOLING:	Forced Air
RFI SUPPRESSED:	Within 15 dB of Mil-I-26600 and Mil-I-6181
DIMENSIONS:	
Width	19 in.
Height Over Casters or Feet	23-1/2 in.
Depth	24 in.
Rack Mounting Height	23-3/4 in.
WEIGHT:	460 lbs.

NOTES:

1. Ripple and transient response are degraded by a factor of $(60/f)^2$ when unit is operated at frequencies below 60 Hz (f is line frequency).
2. At nominal input and full rated output.
3. Specified for all inputs except 342-418 V input where the output range is 0 - 540 V.
4. It is recommended that a 20 ohm bleeder be connected across the output terminals for operation below 30 volts.
5. Specified for all units except 342-418 V input where the output range is 0 - 500 V.
6. The dynamic voltage range may be extended to 0 - 600 V by adjusting no-load voltage to 660 V. Use COARSE and FINE VOLTAGE ADJUST controls for this purpose. If these are not sufficiently effective, use internal resistor R39, noting that any adjustment of R39 may alter zero-output-voltage setting. See Figure 1-1.
7. Programming current is approximately 2 mA in voltage mode; about 3 mA in current mode.

Table 1-1. Unit Specifications. (Sheet 2 of 2)

SECTION II

PREPARATION FOR USE

2-1 GENERAL

2-2. After unpacking, inital inspections and preliminary checkout procedures should be performed to assure that the unit is in good working order. These consist of visually checking for damaged parts and components, and making an electrical check. If it is determined that the unit is damaged, the carrier should be notified immediately. Repair problems should be directed to the nearest Raytheon/ Sorensen representative, or to the Service Department, Raytheon Company, Sorensen Power Supplies, Manchester, New Hampshire.

2-3. INSPECTION.

2-4. Proceed as follows to inspect for damage incurred during shipment:

a. Check meter faces for cracked or broken glass. Check each meter pointer for zero indication. Use zero adjust to bring indicator to zero, if necessary.

b. Look for cracked or broken lenses on the indicating lights.

c. Rotate the FINE and COARSE VOLTAGE ADJUST and CUR.ADJ.AMPS potentiometers. Knobs should turn smoothly through a 300-degree angle.

d. Test for positive action of circuit breaker by operating a few times. Set breaker to OFF position.

e. Detach side panels, and inspect for loose connections and structural damage.

f. Remove front-panel retaining screws, located on either side of unit, and gently separate panel a few inches from chassis to allow internal inspection. Then, check tightness of screw-type connections at the transformer and silicon-controlled rectifier board. Reinstall panel using screws originally removed.

g. Remove right-hand, rear panel and inspect for loose connections. Make sure that the links connected between terminals 1-2 and 3-4 on terminal board TB2 , located at the upper left-hand side of the input panel, are securely fastened. Reinstall panel.

2-5. If any optional equipment (refer to Table 1-2) has been purchased with the unit, assure that all parts are accounted for and that no damage has been incurred in shipment. Optional parts are normally shipped loose in the packaging carton except the overvoltage protector which is factory installed.

2-6. OPTIONAL EQUIPMENT INSTALLATION.

2-7. The unit is shipped in a ready-to-use state. However, if optional accessories have been purchased, some must be installed at destination. The following paragraphs, therefore, delineate accessory installation.

2-8. CASTER KIT. Install the casters as follows:

a. Raise the unit off the floor until the feet are sufficiently exposed to enable removal, then detach feet.

b. Mount casters to support brackets and align brackets over holes vacated by feet. Attach with hardware provided.

Note

The two casters with braking mechanisms are to be mounted over the forward holes.

2-9. SUPPORT KIT. Mount the left- and right-hand angle brackets to the vertical rack channels at an elevation which insures cradling of the unit.

2-10. MECHANICAL INSTALLATION.

2-11. The unit is shipped ready for floor use. However, if it is to be rack mounted, eye hooks at the top of the unit and feet below must be removed. Inasmuch as it has a relatively large mass, the unit should be inserted into a slot at or near the bottom of the rack. If one of the three-phase inputs other than 460 V is to be used, it may be easier to make the necessary wiring changes prior to installing the unit (refer to para 2-12 through 2-18).

2-12. ELECTRICAL INSTALLATION.

2-13. The unit is factory wires to accept a 460 volt three-phase input. However, by making a few wiring changes at transformers T1, T2, T3, T4 and T5, the unit may be altered to accept either a 208, 230, 380 or 415 volt input. Transformers T1, T2 and T3 are located behind the front panel on the left-hand side of the unit. Transformer T4 is at the lower-left-hand side of the rear panel and transformer T5 is directly below terminal board (TB2) on the rear panel. Tap numbers are stenciled on transformers.

CAUTION

Unit is phase-rotation sensitive. Before connecting input, check rotation per para 2-22.

Note

Unit will accept frequencies below 57 Hz for 380 and 415 volt input only.

2-14. 460 VOLT OPERATION. Unit is shipped wired to accept a 460 volt input. Check phase rotation (para 2-22) before connecting input to terminal board TB1 .

2-15. 208 VOLT OPERATION. To adapt unit from a 460 volt input configuration to a 208 volt input, see Figure 2-1 and proceed as follows:

a. At transformers T1, T2, and T3, relocate two wires at terminal 6 to tap 5. Unsolder jumper across terminals 3 and 13, and reconnect across taps 2 and 5. Solder a jumper across terminals 12 and 13.

b. At transformer T4, remove jumpers across terminals 16 and 17, 2 and 3, and 27 and 28. Solder new jumpers across terminals 15 and 17, 16 and 19, 1 and 3, 2 and 5, 26 and 28, and 27 and 30.

c. At transformer T5, relocate orange wire from tap 8 to tap 7. Unsolder jumper across terminals 4 and 5. Connect new jumpers across taps 1 and 5, and 3 and 7.

d. Check input phase rotation per para 2-22.

2-16. 230 VOLT OPERATION. To adapt unit from a 460 volt input configuration to a 230 volt input, see Figure 2-1 and proceed as follows:

a. At transformers T1, T2, and T3, detach jumper at terminal 13 and reconnect at terminal 6. Connect a jumper across terminals 12 and 13.

b. At transformer T4, remove jumpers across terminals 16 and 17, 2 and 3, and 27 and 28. Solder new jumpers across terminals 15 and 17, 16 and 19, 1 and 3, 2 and 5, 26 and 28, and 27 and 30.

c. At transformer T5, remove jumper across terminals 4 and 5. Connect jumpers between terminals 1 and 5, and 4 and 8.

d. Check input phase rotation per para 2-22.

2-17. 380 VOLT OPERATION. To rewire unit from 460 volt to 380 volt operation, proceed as follow

a. At transformers T1, T2, and T3, relocat two wires at terminal 6 to tap 5. Unsolder jumper at terminal 3 and relocate to tap 2.

b. At transformer T4, relocate jumper at terminal 30 to tap 29, jumper at terminal 5 to tap 4, and jumper at terminal 19 to tap 18.

c. At transformer T5, unsolder brown wire at tap 8 and relocate at terminal 10. Relocate orange wire at tap 8 to tap 9. Unsolder jumper at terminal 4, and resolder at tap 3.

d. Check input phase rotation per para 2-22.

Note

With a 380 volt input, maximum d-c output voltage is 540 V.

2-18. 415 VOLT OPERATION. To rewire unit from 460 volt to 415 volt operation, proceed as follow

a. At transformer T1, T2, and T3, unsolder jumper at terminal 3 and resolder at tap 2. Relocate two wires at terminal 6 to tap 5.

b. At transformer T5, relocate orange wire at tap 8 to tap 7. Unsolder jumper at terminal 4 and relocate to tap 3.

c. Check unit phase rotation per para 2-22

2-19. INITIAL CHECKOUT.

2-20. VOLTAGE MODE. To perform a check of voltage-mode regulation, proceed as follows:

a. Assure that proper input connections have been made. Refer to para 2-12 through 2-18.

b. Turn COARSE and FINE VOLTAGE ADJUST and CUR.ADJ.AMPS controls fully counter-clockwise.

Note

See Figure 3-1 for location of controls and indicators.

c. Set unit circuit breaker to ON.

d. Turn COARSE VOLTAGE ADJUST control slowly clockwise and observe unit voltmeter. Pointer should swing up scale.

e. With 300volts indicated on the meter, turn FINE VOLTAGE ADJUST control from stop-to-stop. Range should be about 30 V.

f. Set circuit breaker to OFF position.

2-21. CURRENT MODE. To check operation of the unit in the current mode, proceed as follows:

a. Turn FINE and COARSE VOLTAGE ADJUST and CUR.ADJ.AMPS controls fully counter-clockwise.

b. Connect a heavy-gage wire across the output terminals. One of the intended output leads is recommended for this purpose.

c. Set unit circuit breaker to ON.

d. Rotate FINE VOLTAGE ADJUST control about 30° from left-hand stop and observe output meters. Ammeter should indicate 0 amps, and voltmeter a fraction of a volt.

e. Rotate FINE VOLTAGE ADJUST control fully clockwise.

f. In steps using small increments, rotate CUR.ADJ.AMPS to 8 while observing ammeter. Ammeter should read output current equal to that set on control.

g. Set unit circuit breaker to OFF.

h. Remove shorting wire from output terminals.

2-22. PHASE-ROTATION CHECK.

2-23. The DCR is a phase-rotation sensitive unit, with a rotation sequence of 1-2, 2-3, 3-1. To check rotation:

a. Connect two lamps and a coil as shown in Figure 2-2, for 208, and 230 volt inputs. Use four lamps for other inputs. Mark the free-ended leads 1,2 and 3 as indicated in the figure.

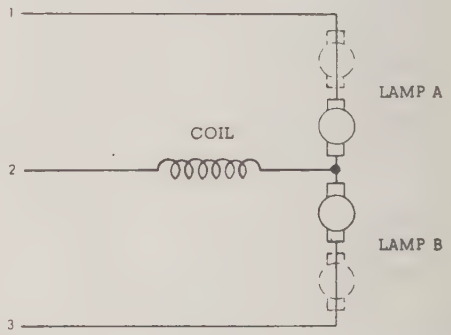
b. Hook-up the 3 phase input leads to the test circuit and apply power.

c. Observe the lamps. If lamp A is brighter than lamp B, the phase sequence is correct. If, however, lamp B is brighter than lamp A, disconnect input power and interchange input connections at 2 and 3. If a capacitor is used in test circuit, sequence is correct if lamp B is brighter than A.

d. Apply power and observe lamps. Lamp A should be brighter than B.

e. Tag mark the input leads 1, 2 and 3 to correspond with markers on test apparatus leads.

f. Disconnect power and then disconnect input leads from test set-up. Connect input leads to unit or auxiliary supply at proper terminals, i.e. input lead 1 to terminal 1, etc.

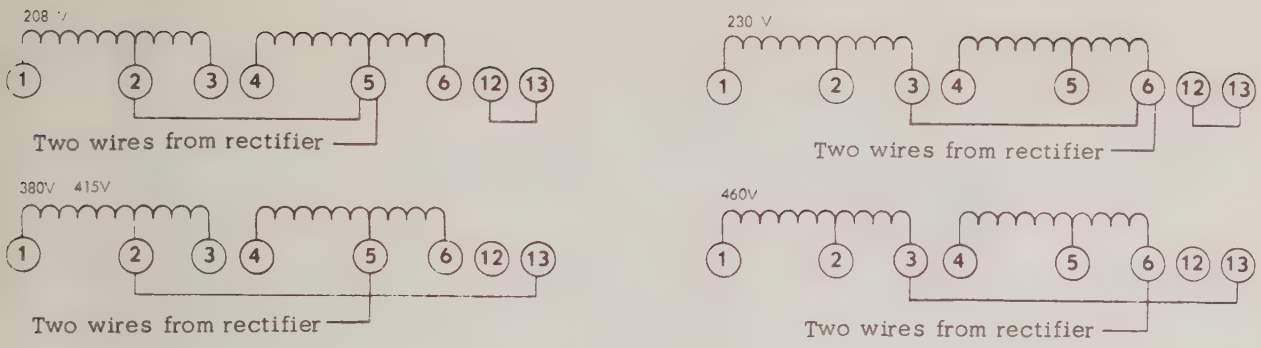


INPUT	LAMP A	LAMP B	COIL
208 V, 230 V 380 V, 415 V, 460 V	230 V, 100 W Two 230 V, 100 W In Series	230 V, 100 W Two 230 V, 100 W In Series	1 Henry* 2 Henry*

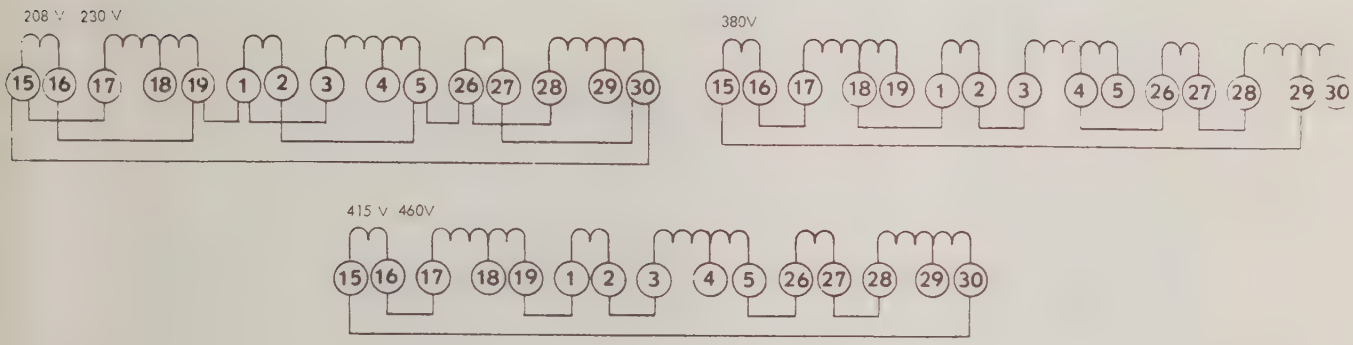
* A 10 μF capacitor may be used in lieu of a 1 henry coil for 208 V or 230 V input. With a 380 V, 415 V, or 460 V input, a 5 μF capacitor may be used as a substitute for the 2 henry coil.

Figure 2-2. Phase Rotation Set-up.

TRANSFORMERS T1, T2, and T3


208 V
1 2 3 4 5 6 12 13
Two wires from rectifier
230 V
1 2 3 4 5 6 12 13
Two wires from rectifier
380V 415V
1 2 3 4 5 6 12 13
Two wires from rectifier
460V
1 2 3 4 5 6 12 13
Two wires from rectifier

TRANSFORMER T4



TRANSFORMER T5

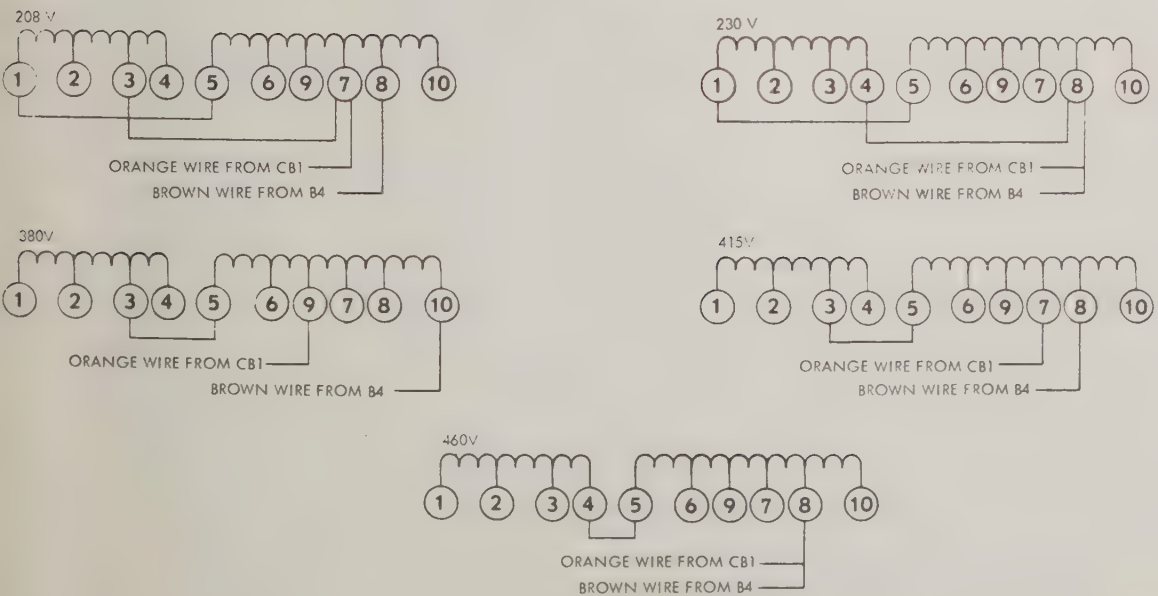

208 V
1 2 3 4 5 6 9 7 8 10
ORANGE WIRE FROM CB1
BROWN WIRE FROM B4
230 V
1 2 3 4 5 6 9 7 8 10
ORANGE WIRE FROM CB1
BROWN WIRE FROM B4
380V
1 2 3 4 5 6 9 7 8 10
ORANGE WIRE FROM CB1
BROWN WIRE FROM B4
415V
1 2 3 4 5 6 9 7 8 10
ORANGE WIRE FROM CB1
BROWN WIRE FROM B4
460V
1 2 3 4 5 6 9 7 8 10
ORANGE WIRE FROM CB1
BROWN WIRE FROM B4

Figure 2-1. Unit Input Connections

SECTION III

CONTROLS AND INDICATORS

3-1. GENERAL.

3-2. This section provides a tabular listing of the unit's controls and indicators, along with a brief description of their function. The physical location of the controls and indicators is shown in Figure 3-1; for schematic locations, see Figure 7-2.

CONTROL/INDICATOR	FUNCTION
COARSE VOLTAGE ADJUST	A 3k ohm potentiometer across which the reference voltage for voltage-mode operation is developed. Used to adjust the output from 0 to 600 volts.
FINE VOLTAGE ADJUST	A 150 ohm potentiometer connected in series with the COARSE VOLTAGE ADJUST potentiometer and used to make small but sensitive variations in the output voltage.
CUR. ADJ. AMPS	A 150 ohm potentiometer used in the first stage of the current mode amplifier to vary the reference and subsequently the output current from 0 to 18 amperes.
CURRENT MODE Indicator	A green light which, when glowing brightly indicates that the unit is operating in the current regulating mode.
Unit Circuit Breaker	A 460 V, 65 A, three-pole circuit breaker wired between the input terminal board and the main transformer. Used to connect, or disconnect, incoming power to, or from, the unit, and to protect the unit in event of internal failure.
POWER ON Indicator	A red light, connected across the secondary of transformer T4 , which, when glowing, indicates that the unit circuit breaker is closed and that at least one phase of input power is being supplied to the main transformer.

Table 3-1. Controls and Indicators (Sheet 1 of 2)

CONTROL/INDICATOR	FUNCTION
PHASE FAILURE Indicator	An amber light which, when glowing, indicates a failure of a phase of input power. This type of failure will drop output automatically to zero.
THERMAL OVERLOAD Indicator	An amber light which, when glowing, indicates unit is overheating. A thermal failure causes an automatic drop to zero output.
Unit Ammeter	A 0 to 20 A ammeter connected in the positive leg of the unit output. Indicates output current.
Unit Voltmeter	A 0 to 800V voltmeter connected internally across the SENSE terminals of terminal board TB2 to give an indication of unit voltage output.

Table 3-1. Controls and Indicators (Sheet 2 of 2)

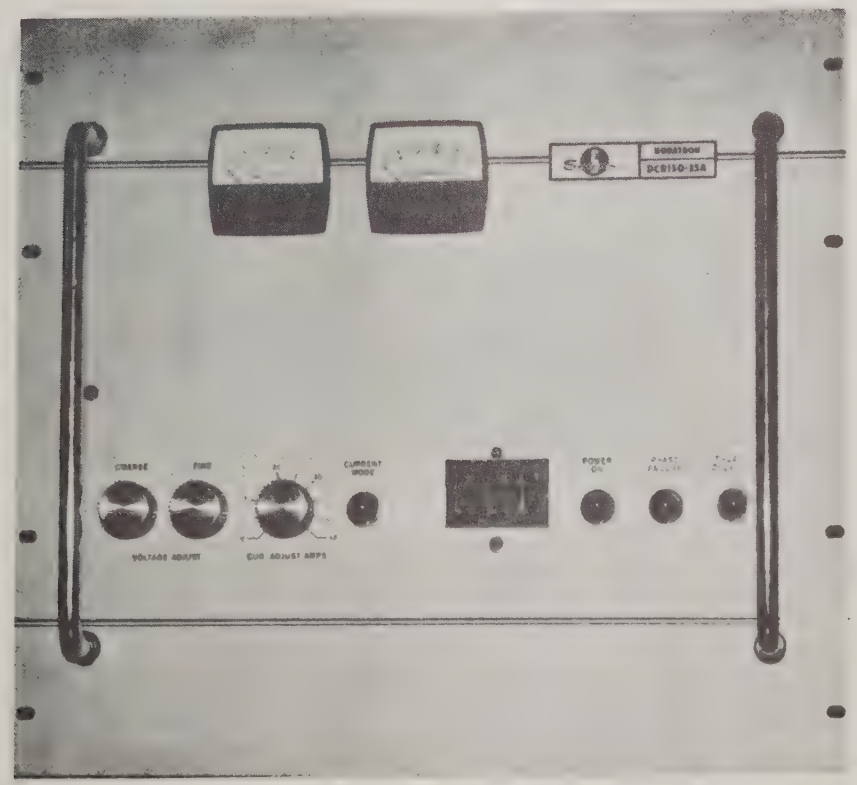


Figure 3-1. Control Panel
Model DCR 150-35A Shown

SECTION IV
OPERATING INSTRUCTIONS

4-1. GENERAL.

4-2. This section provides instructions on how to adapt the unit to many of its varied applications. It delineates procedures to be followed for conversion to remote-sensing operation, voltage-, current- and resistance programming modes, and parallel operation.

4-3. LOCAL SENSING.

4-4. The unit is shipped ready for use in the local-sensing mode. This simply means that the sensing circuit is connected across the unit output terminals, and therefore, the unit is voltage regulating at these terminals and not at the load. For applications where the voltage drop in the load lines is prohibitive, use remote sensing (para 4-7). Figure 4-1 illustrates the local-sensing configuration of terminal board TB2.

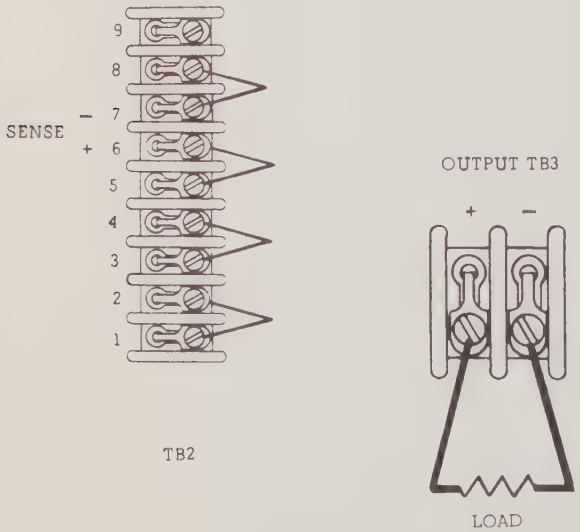


Figure 4-1. Local-sensing Configuration

4-5. VOLTAGE MODE. To put the unit in voltage-mode operation, proceed as follows:

a. Rotate the FINE and COARSE VOLTAGE ADJUST and CUR.ADJ.AMPS potentiometers (see Figure 3-1) fully counterclockwise.

b. Connect the three-phase input leads as stipulated under para 2-13.

c. Set unit circuit breaker to ON. POWER ON light glows.

d. Rotate COARSE VOLTAGE ADJUST until the unit voltmeter indicates the desired output voltage. Use FINE VOLTAGE ADJUST for small sensitive adjustments.

Note

For output below 30 V, connect a 20 ohm bleeder across output terminals to preclude inherent SCR random firing at extremely low output.

e. Set unit circuit breaker to OFF.

f. Connect load lines to unit output terminals on terminal board TB3.

g. Turn CUR.ADJ.AMPS control to a value at least 1.8 A above the actual load current.

Note

Regulation falls off if output current is within 1.8 A of limiting value. Current mode indicator begins to glow when current output is within approximately 2.7 A of limiting current.

h. Set unit circuit breaker to ON. POWER ON light glows, and the unit is in voltage-mode operation.

Note

With unit in the voltage mode, an increase in load current requirements above value set in step "g" will cause an automatic crossover to current-mode (current-limiting) operation.

4-6. CURRENT MODE. To operate unit in the current mode, proceed as follows:

a. Rotate the FINE and COARSE VOLTAGE ADJUST and CUR.ADJ.AMPS controls (see Figure 3-1) fully counterclockwise.

b. Connect three-phase input (para 2-13).

c. Set unit circuit breaker to ON.

d. Rotate COARSE VOLTAGE ADJUST until unit voltmeter indicates 60 volts above the desired dynamic voltage.

Note

Current regulation falls off if the dynamic (compliance) voltage is within 30 V of voltage limiting value.

e. Set unit circuit breaker to OFF.

f. Connect load lines to unit output terminals on terminal board TB3.

g. Turn CUR.ADJ.AMPS control to desired current-regulating value. POWER ON light glows, and unit is in current-mode operation.

Note

If compliance (dynamic) voltage rises above limit set in step "d", the unit automatically crosses over to voltage-mode operation.

4-7. REMOTE SENSING.

4-8. A few link changes at the rear panel and alterations at the load terminations of the output leads are all that are required to convert the unit to remote-sensing operation. In this mode, voltage regulation is at the load rather than at the unit output terminals, thus correcting for voltage drops in the load lines.

Note

A 3 volt drop per line is the maximum for which remote sensing will compensate. Voltage across load is equal to voltage output of unit minus line drops.

4-9. To adapt unit for remote-sensing operation, proceed as follows:

a. Set unit circuit breaker to OFF.

b. Remove local-sensing links at the plus and minus SENSE of terminal board TB2. See Fig. 4-2.

Note

Use a twisted or shielded pair of wires for the sensing leads. Sensing current is about 10 mA.

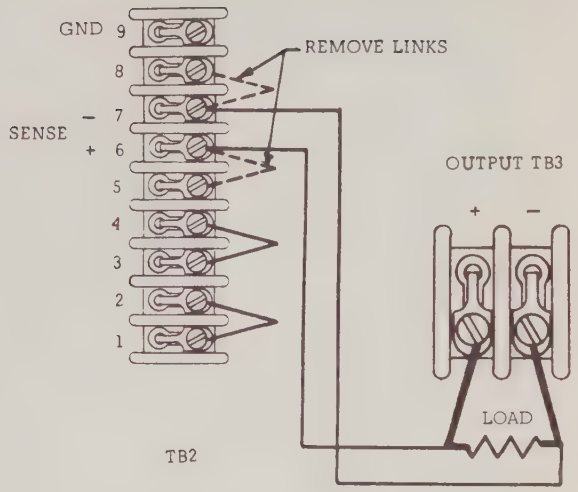


Figure 4-2. Remote-sensing Configuration

c. Connect the lead from the positive sense terminal to the positive load terminal, connect the other lead at the negative load terminal.

d. Reset current limit per para 6-14.

e. If the unit is being placed in line for the first time or is being returned to the line following a maintenance check, etc., proceed as outlined under para 4-5. Otherwise, set unit circuit breaker to ON. POWER ON indicator glows and the unit supplies load.

4-10. EXTERNAL RESISTANCE PROGRAMMING.

4-11. VOLTAGE MODE. The unit output voltage may be programmed externally to a predetermined, regulated value. This is done by connecting a resistance into the voltage reference circuit of the voltage-mode section. Terminals on TB2 are provided for this purpose.

4-12. Voltage-programming sensitivity is approximately 5 ohms per volt, plus or minus 10 percent. This means that for a certain voltage output, the voltage value must be multiplied by 5 to obtain the programming resistance. The resistor used should have a low temperature coefficient

(± 30 ppm) to maintain the unit's rated temperature characteristics as well as stability. Programming current is about 2 mA. Choose a resistor with a wattage rating at least 10 times that calculated. For a precision calibration of the ohms per volt, see para 4-14.

4-13. To adapt unit to external voltage programming, proceed as follows:

a. Set unit circuit breaker to OFF.

b. Remove link between terminals 3 and 4 (VOLT PROG) on terminal board TB2 and retain.

c. Connect programming resistor across terminals 3 and 4 (see Figure 4-3 for diagram representation of voltage programming hook-up).

d. Rotate COARSE and FINE VOLTAGE ADJUST potentiometers fully counterclockwise.

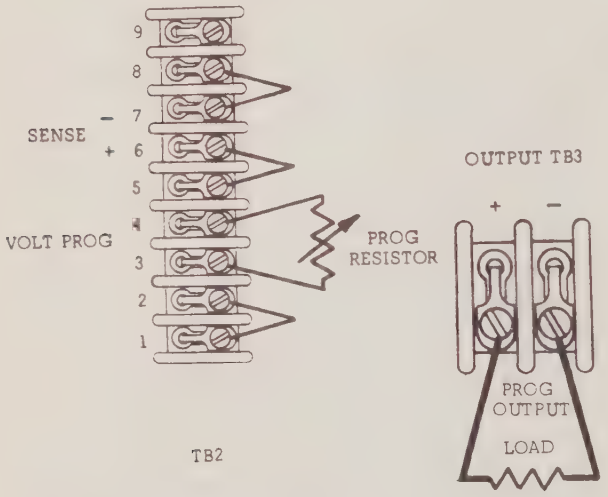


Figure 4-3. Voltage Resistance Programming

Note

The voltage adjust potentiometers are in series with the programming device. Rotation of either of these controls from zero position will affect programmed voltage.

e. If the unit is being used for the first time or is being returned to the line following a maintenance check, etc., assure that input is connected properly (para 2-13) and that a current-limiting value is set on CUR.ADJ.AMPS control.

Note

Regulation will drop off if output current is within 1.8 A of set limit.

f. Set the unit circuit breaker to ON. POWER ON indicator glows.

CAUTION

If voltage programming is to be discontinued, remove programming device and REINSERT LINK BETWEEN TERMINALS 3 and 4 of terminal board TB2.

4-14. PRECISION CALIBRATION. (Voltage Mode). If it is desired to calibrate precisely the programming ohms per volt, proceed as follows:

a. Rotate COARSE and FINE VOLTAGE ADJUST controls fully counterclockwise.

b. Remove link between terminals 3 and 4 (VOLT PROG) on terminal board TB2 and retain.

c. Connect a precision 3k ohm resistor between terminals 3 and 4.

d. Set unit circuit breaker to ON. Allow at least a 30 minute warm-up period.

e. Connect a precision voltmeter across output terminals. Set voltmeter for a range of at least 800 volts.

f. Adjust resistor R39 on component board assembly (located at rear of unit behind left-hand panel) for output reading of approximately 600 volts.

g. Short circuit precision resistor.

h. Adjust resistor R43 on component board assembly for a 0 ± .4 volt output (reset voltmeter range).

i. Remove short circuit, reset voltmeter range to at least 800 volts and adjust R39 for an output of 600 ± 2 volts.

j. Disconnect precision voltmeter.

Note

Unit is now calibrated to programmed voltage ± (.3% + tolerances of precision resistor and voltmeter, and regulation of unit). Linearity of programming is ±.5%.

k. Remove precision calibrating resistor and insert programming resistor. Refer to para 4-12.

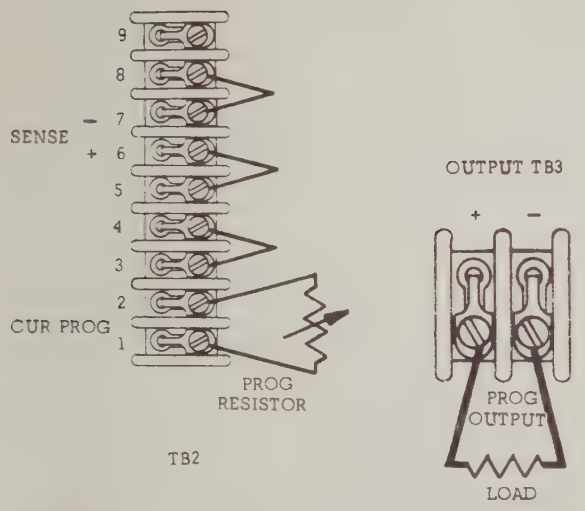


Figure 4-4. Current Resistance Programming

4-15. CURRENT MODE. The unit may be programmed externally to provide a fixed, predetermined output current. This is accomplished by inserting a resistor in the current-mode section reference-voltage circuit (see Figure 4-4 for a diagram illustrating the current-programming configuration).

4-16. Current-programmed sensitivity is 8.3 ohms per ampere. In other words, for every ampere of desired output, the programming resistance must be increased by 8.3 ohms. Programming voltage is about 0.6 V. Use a resistor with a low temperature coefficient (30 ± ppm) and a wattage rating at least 10 times calculated value.

4-17. To convert the unit to current-programming mode, proceed as follows:

a. Set unit circuit breaker to OFF.

b. Remove link between terminals 1 and 2 (CUR.PROG) of terminal board TB2.

c. Insert programming resistor across terminals 1 and 2.

d. Rotate CUR.ADJ.AMPS and COARSE and FINE VOLTAGE ADJUST controls fully counterclockwise.

Note

The programming device is in series with the CUR.ADJ.AMPS control, and therefore, any alteration in the zero setting of this control will be reflected as an increase in the programmed current.

e. If the unit is being used for the first time or if it is being returned to operation following a maintenance check, etc., assure that a 3 phase input is properly connected (para 2-13).

f. Disconnect load lines, if connected; set unit circuit breaker to ON.

g. Rotate COARSE VOLTAGE ADJUST control until unit voltmeter indicates 30 volts above desired dynamic voltage.

Note

Current regulation will drop off if dynamic voltage rises to within 30 volt of voltage setting.

h. Set unit circuit breaker to OFF, and reconnect load lines.

i. Set unit circuit breaker to ON. POWER ON indicator glows.

CAUTION

If current programming is to be discontinued remove programming device and REINSERT LINK BETWEEN TERMINALS 1 and 2 of terminal board TB2.

4-18. EXTERNAL SIGNAL PROGRAMMING.

4-19. VOLTAGE. The unit may be programmed externally to provide a variable output as a function of an input voltage signal. This is done by introducing the external signal into the voltage-reference circuit of the voltage-mode stage.

4-20. In selecting a signal source, the following should be considered.

1. The source must be capable of absorbing about 3 mA (the programming current).

2. A floating (ungrounded) source must be used.

3. To obtain a full 0 to 600 volt output range the source must provide a 0 to 8 volt signal (approximately).

4-21. To convert the unit to external voltage signal programming, follow procedures outlined under para 4-13, with one exception. Where step "c" calls for insertion of a resistor across terminals 3 and 4, connect the signal source instead (see Figure 4-5 for connection representation).

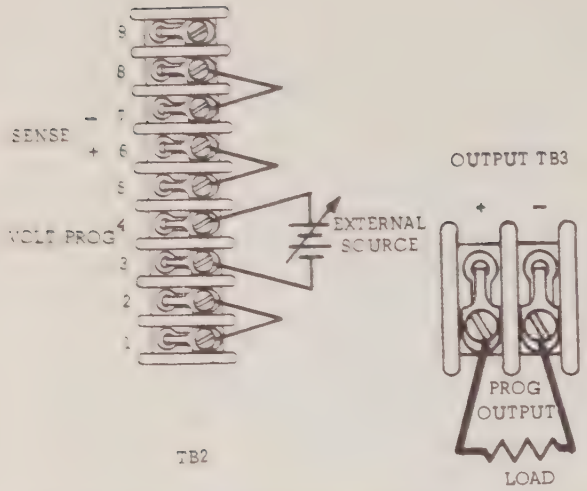


Figure 4-5. Voltage Signal Programming

4-22. CURRENT. A current may be introduced into the reference circuit of the current-mode section to provide a variable current output. This output will be a function of the input signal.

4-23. In choosing a signal source, the following should be considered:

1. The source must be capable of absorbing about 3 mA.

2. It must be ungrounded and,

3. for full rated output range (0 - 18 A) it must provide a 0 to 0.6 volt signal (approx.)

4-24. To adapt the unit to external current-signal programming, follow procedures in para 4-17, with this exception: instead in inserting a programming resistor across terminals 1 and 2 as stated in step "c", insert the programming source. For diagrammatic representation of connections, see Figure 4-6.

4-25. ALTERNATE PROGRAMMING METHODS.

4-26. There is an alternate programming method, for each mode, which eliminates the possibility of altering the programmed output by varying the applicable front-panel control. This is not a preferred method for two reasons: (1) flexibility in using local and external programming together is eliminated and (2) for the voltage mode, the unit voltmeter reads in reverse.

4-27. VOLTAGE RESISTANCE. To use alternate programming method, read and follow the procedures outlined in para 4-11, 4-12 and 4-13, with one exception. Instead of connecting program resistor between terminals 3 and 4 (VOLT PROG) of terminal board TB2 as stated in step "c" of para 4-13, connect resistor between terminal 3 and terminal A (terminal A is located on the upper right-hand side of the component board).

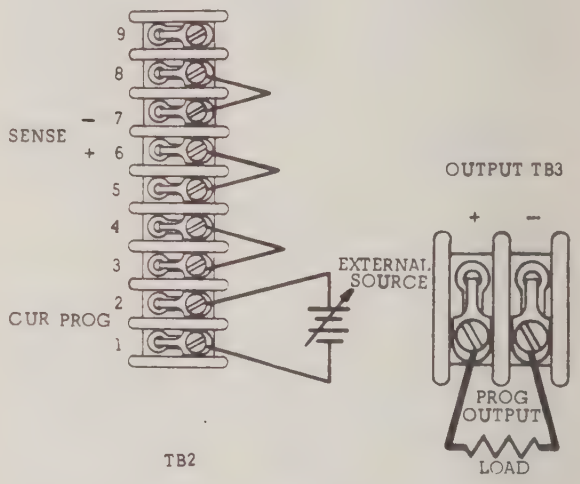


Figure 4-6. Current Signal Programming

4-28. CURRENT RESISTANCE. To adapt unit for current programming, use alternate method, proceed as outlined in para 4-15, 4-16 and 4-17 with this exception. Insert programming resistor between terminal F and terminal D (located on the component board, adjacent to TB2). This step replaces step "c" of para 4-17.

4-29. VOLTAGE SIGNAL. To use alternate programming method, read and follow procedures outlined in para 4-19, 4-20, and 4-21, with one exception: instead of connecting signal source across terminals 3 and 4 (VOLT PROG) connect the source across terminal 3 and terminal A (located at upper right-hand side of component board).

4-30. CURRENT SIGNAL. To use alternate programming method, read and follow procedures outlined in para 4-22, 4-23, and 4-24, with one exception: instead of connecting signal source across terminals 1 and 2 (CUR PROG),

connect source between terminal F and terminal D (located on component board, adjacent to terminal board TB2).

4-31. PARALLEL OPERATION.

4-32. Paralleling of three-phase DCR units is accomplished directly by connecting individual supplies to the load. Using this method, no current derating due to composite tolerances of wire resistance, components, etc. is required. There are no restrictions on the number of units that may be paralleled. However, paralleling units does result in lower overall regulation.

4-33. The following delineates procedures to be followed in directly paralleling two units. However, the procedures are applicable to any number of units (see representative diagram in Figure 4-7).

Note

The paralleled units may be adapted for remote-sensing as illustrated in Figure 4-7. They may also be adapted for resistance or signal programming. However, none of these is required for parallel operation.

a. Set unit circuit breakers of both units to OFF.

b. Disconnect output lines and sensing links at both units. Connect local-sensing links.

c. Set both unit circuit breakers to ON. POWER ON indicators glow.

d. Rotate COARSE VOLTAGE ADJUST control at one unit to desired output; repeat procedure for other unit. Match unit output voltage by using respective FINE VOLTAGE ADJUST controls.

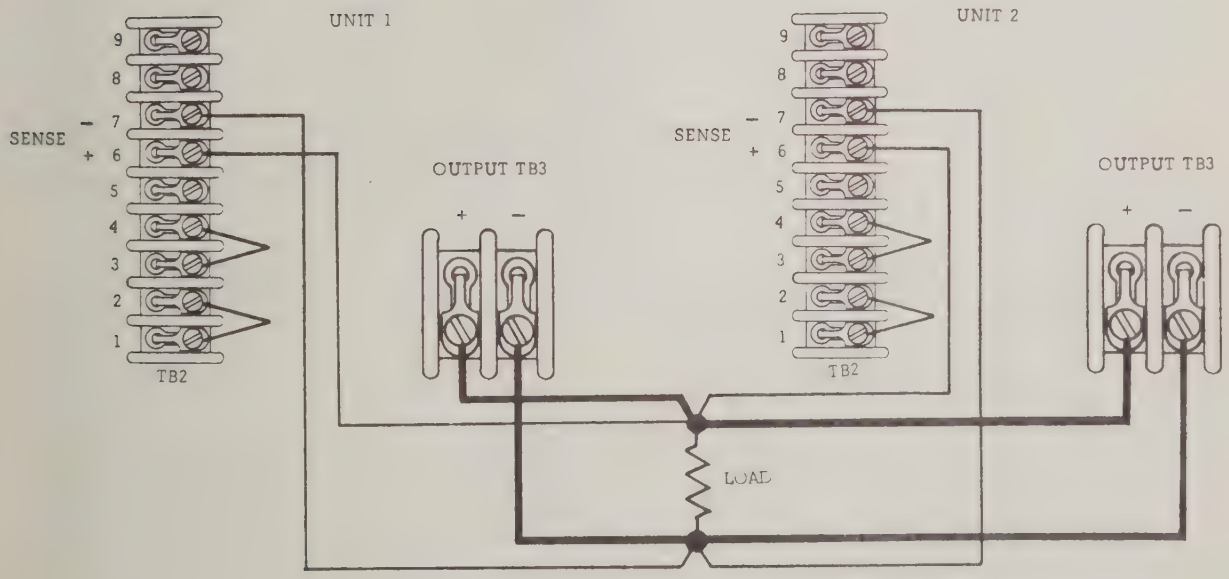


Figure 4-7. Parallel Operation (with remote sensing)

e. Set CUR.ADJ.AMPS control on each unit to one-half of the total desired limiting current, e.g., if desired to limit load current at 14 A, set each control to 7 A.

f. Connect output cables from each unit to load. For remote-sensing, remove local-sensing links and connect as shown in Fig. 4-7.

g. Set both unit circuit breakers to ON. POWER ON indicators glow. The unit which is supplying the highest voltage (it is impossible to identically match the output voltages) will supply load. If the load requirements exceed the setting on CUR.ADJ.AMPS control, this unit will automatically crossover to current-mode operation and its output voltage will drop. The second unit will then assume that portion of the load rejected by the first. Any further increase in load will be supplied by the second unit up to its current-limiting setting. Regulation, therefore, will be the sum of the regulation of the two units plus the difference in the voltage settings.

SECTION V

PRINCIPLES OF OPERATION

5-1. INTRODUCTION.

5-2. This section is designed to provide the user with a general knowledge of the internal operation of his unit. An understanding in this area is essential to the rapid and logical isolation of any unit malfunction.

5-3. To facilitate the treatment of what is a relatively complex subject, a brief sketch, with reference to unit block diagram in Figure 5-1, is given first. This is followed by detailed discussions on the various section and sub-sections which comprise the block diagram.

5-4. FUNCTIONAL DESCRIPTION.

5-5. For an understanding of basic unit operation, it is important to understand what is meant by phase control. Consider Figure 5-2, which for the sake of simplicity, represents only a single-phase input voltage to a resistive load. If by some means, conduction of this voltage can be delayed, then the average voltage output of the positive half-cycle will be reduced. Control of the delay, then, results in control of the average voltage. This is phase control, and the device used in the Model DCR to effect this delay is the silicon controlled rectifier (SCR). The delay is expressed in degrees and is known as the firing angle. Figure 5-2 shows firing angles of 60° (shaded area plus cross-hatched area) and 120° (cross-hatched area only).

5-6. A discussion of the block diagram in Figure 5-1 follows: in the main power circuit, the three-phase input voltage is fed into the main transformer and SCR control. The output of the transformer is rectified and then L-C filtered to deliver dc at the output.

5-7. In addition to the main transformer, there is an auxiliary transformer, delta connected across the input, which provides power for both a control-circuit voltage-regulator and the SCR firing network. This network uses transformer output to correctly sequence the SCR firings with the appropriate phase. The control circuit voltage-regulator provides a highly stable, precise voltage for the voltage- and current-mode sections. The former section monitors the output voltage, and when variations occur in the output, it signals the SCR firing network to alter the SCR firing angle. This results in either a compensating increase or decrease in the main transformer output, which is reflected instantaneously in the unit output.

5-8. The current-mode section performs basically the same function as the voltage-mode only it is, of course, monitoring current output while the unit is current regulating.

5-9. DETAIL DESCRIPTION.

5-10. The following paragraphs provide a detailed functional description of the various operating sections. For schematic location of the component reference designations used liberally throughout the discussions, see Figure 7-2.

5-11. CONTROL CIRCUIT VOLTAGE REGULATOR.

5-12. The control-circuit voltage-regulator provides 20 volts of highly stable, precise output. It consists of two differential amplifiers Q5-Q6 and Q3-Q4, a zener diode CR20, a passing stage Q2 and a constant-current generator CR18 - CR19 - R14 - R15 - Q1. Output appears across capacitor C10. This section is supplied by transformer T4 through a center-tapped, full wave bridge CR16 - CR17.

5-13. The output voltage of the supply is sensed across potentiometer R20 where a portion of the drop here is compared with a voltage reference created by diode CR20. Resulting error signals are amplified and fed to the base of passing stage Q2. Q2 acts as a variable impedance, increasing or decreasing the voltage drop across the

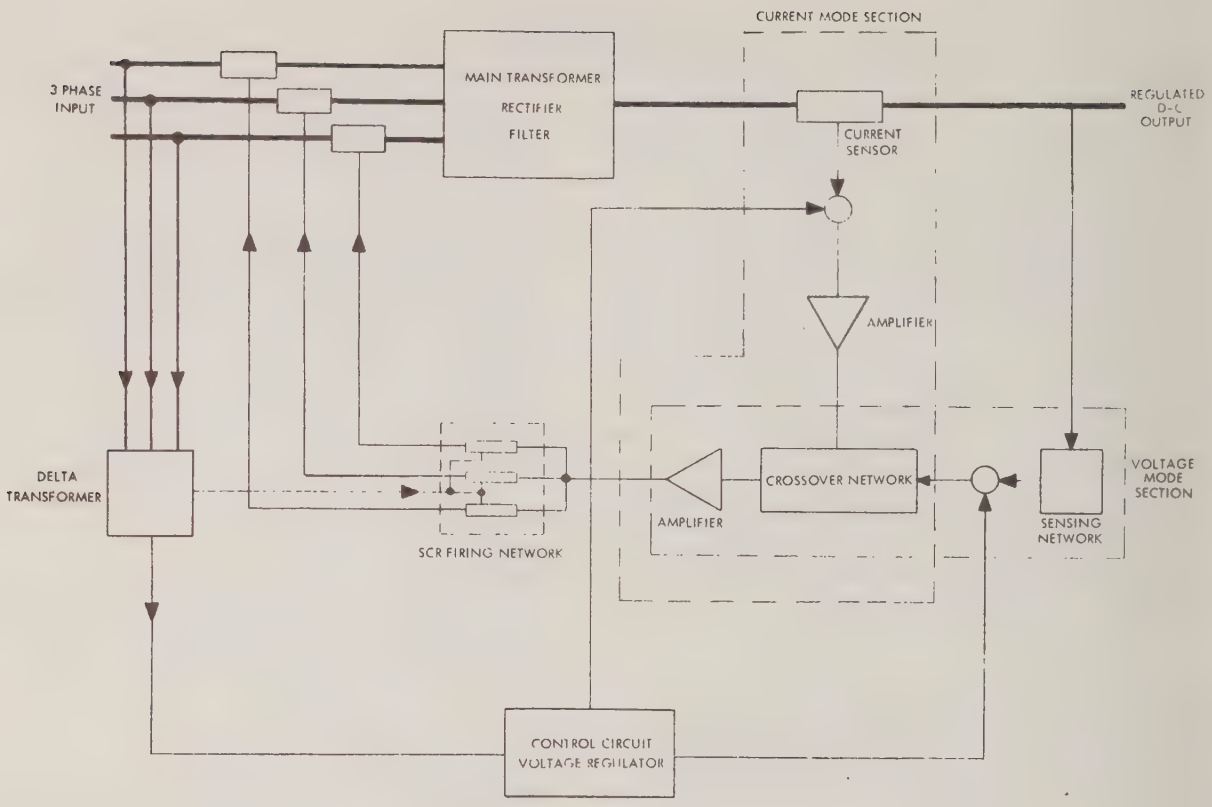


Figure 5-1. Unit Block Diagram

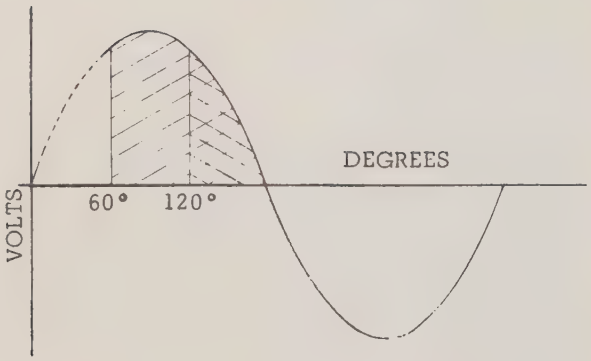


Figure 5-2. Single-Phase Input Wave

stage as a function of the output voltage.

5-14. As an example of circuit operation, assume that a rise in voltage is sensed across R20. The base of Q6 will become more positive, and more current will flow through the transistor. This results in a decrease in the current available for the base of Q4. Q4 conducts less, and transistor Q3 conducts more. Since the current from generator Q1 - CR18 - CR19 - R14 - R15 is constant, an increase in current through Q3 results in a decrease in current to the base of passing stage Q2. This effectively increases the impedance and the voltage drop across the stage. The rising voltage is then curtailed by the drop to ensure that a 20-volt potential is maintained.

5-15. VOLTAGE MODE SECTION.

5-16. The voltage-mode section monitors the output voltage, detects variations and fluctuations and sends an error signal to the SCR firing network. It consists of a differential amplifier Q12 - Q13, constant-current generators

Q9, Q11, Q14 and their associated circuitry and emitter follower Q7.

5-17. The circuit functions as follows: output voltage is divided across resistors R51- R52, a beta network, with a sample of the voltage appearing across the base-emitter of transistor Q13. This voltage is compared with a reference voltage developed across resistors R41, R42, R43. The resulting voltage error will cause an increase in current in either Q12 or Q13. An increase in Q12 current will occur if the sensed output voltage is decreasing; Q13 current will increase if output voltage is increasing. For example, if the output voltage starts to rise, the base of Q13 will become more positive resulting in an increase of current through Q13. Inasmuch as current generator Q14 will only pull a constant current and since the current through Q13 has increased the current through Q12 and, therefore, resistor R46 will decrease. The voltage drop across the resistor will decrease, and this drop will be reflected in the output of emitter follower Q7. Q7 output is directed to the SCR firing network where its voltage level is used as a determinant in firing-angle delay.

5-18. Constant-current generator Q9 supplies an operating current to transistor Q12 allowing resistor R46 to have a large value. This large value results in greater gain.

5-19. The voltage reference for the differential amplifier, derived from both the constant voltage of the internal voltage regulator (refer to para 5-11) and a constant current generated by Q11, is developed across resistors R41, R42 and R43. R41 and R42 are the control-panel potentiometers which, by varying the amplifier reference voltage, adjust the output voltage. No variations in differential-amplifier current due to the variable reference voltage are observed because transistor Q14 pulls a constant current through the amplifier.

5-20. CURRENT-MODE SECTION.

5-21. The current-mode section consists primarily of current-sensing resistor R13, variable resistors R23, R24, R25, amplifier Q8- Q10 and diode CR23. These function in conjunction with constant-current generator Q14 to effect crossover and limit the current output to the selected value.

5-22. The circuit works as follows: when the output current rises above the selected value (R24 is the current output adjust), the drop occurring across resistor R13 is sufficient to reduce the conduction level of Q8. The collector output of Q8 is then fed to the base of Q10, which increases the current flow through this transistor. Its output is fed both to the emitter of Q14 and the base of Q15. Sufficient drive on the base of Q15 will result in the energization of the current-mode indicator circuit. The current into the emitter of Q14, however, provides the limiting feature. This current may be considered as part of the constant current of Q14. Therefore, the current into the collector of Q14 must decrease to maintain the constant level. This results in a drop in the voltage across resistor R46. This diminution is reflected in the output of emitter follower Q7 and subsequently results in an increased delay of SCR firing. This reduces the output current.

5-23. Reference for amplifier Q8 is provided by the voltage-regulator section (refer to para 5-11) and resistors R23, R24, R25, and R26.

5-24. SCR FIRING NETWORK.

5-25. Three separate but identical firing circuits, one for each phase, comprise the firing network. Power for the network is derived from transformer T4. This transformer has a delta-connected primary, and three single-phase and two wye-connected secondaries. The single-phase secondaries are connected to the firing circuits, one per phase. This insures the correct phase relationship between a firing circuit and the voltage across its SCR. A typical firing circuit consists of resistor R59, zener diode CR28, transistor Q16, capacitor C21, unijunction transistor Q17 and pulse transformer T6. On Figure 7-2, the remaining two circuits are located directly below the aforementioned.

5-26. Basically, the circuit works as follows: input from the secondary of transformer T4 is clipped by zener CR28, and fed across transistor Q16 and unijunction transistor Q17. Q16 is a constant-current generator whose output is determined by the voltage drop across R22 in the emitter-follower Q7 circuit. (The drop across R22 is a function of the main output. Refer to para 5-17 and 5-22). Q16, then, controls the charge rate of capacitor C21. This rate is

important since the charge on C21 determines the firing point of unijunction transistor Q17. As a charge builds up, Q17's breakover voltage is surpassed and C21 discharges through Q17 to the pulse transformer T6. The pulse is fed to the gate of silicon-controlled rectifier CR1, and the SCR fires.

5-27. As a further amplification of circuit function, assume that there is a rise in output voltage. The drop across R22 is then lowered, and the current through Q16 is diminished. The charging rate of C21 is slowed, and discharge through Q17 is delayed. This results in a retardation in the SCR firing angle and a subsequent decrease in the average output of bridge CR11-CR12.

5-28. PHASE-FAILURE SHUTDOWN.

5-29. If a phase of input line fails, a lamp DS4 will glow and unit output will go to zero. The failure sensing and shutdown circuit consists of two wye-connected secondaries of transformer T4, diodes CR31 through CR36, relays K1 K2, lamp DS4, resistor R71, and constant-current generator Q14.

5-30. The circuit functions as follows: removal of an input phase will cause an unbalance in the phase voltages being compared across relays K1 and K2. This unbalance causes a current to flow in either relay, and the affected relay trips. Closing of either relay's contacts makes the circuit between a power source CR34 - CR35 - CR36 and the indicating light. The current flowing through the light is also introduced into the emitter circuit of Q14, and causes a large decrease in the current flowing through R46. The output then drops to zero (refer to para 5-17 and 5-26 for an explanation of how a drop in the voltage across R46 decreases the main output voltage). Resistor R71 across lamp DS4 insures shut down if the lamp burns out.

5-31. THERMAL OVERLOAD SHUTDOWN.

5-32. If the unit overheats, one of three thermostats (either S1, S3, or S4) energizes lamp DS1 to give an indication of failure and also introduces a large current into the emitter of Q14. The output voltage then drops to zero due to the decrease in drop across resistor R46. (Refer to para 5-17 and 5-26 for an explanation of how this comes about). Resistor R55 insures operation of the fan-failure circuit in the event of lamp DS1 failure.

5-33. RADIO FREQUENCY SUPPRESSION.

5-34. Choke coils L1, L2 and L3 and capacitors C37 through C40 suppress radio-frequency interference arising from semiconductor commutation.

SECTION VI
MAINTENANCE

6-1. GENERAL.

6-2. This section is designed to provide the user with sufficient data for the maintenance and repair of his unit. In addition, calibration procedures are included which, if performed as specified, will serve to keep the unit at peak performance throughout its long operating life.

6-3. The material herein is presented as follows: a general troubleshooting chart outlines obvious troubles for common symptoms. Where these common troubles require deeper analysis, a reference is made to a test procedure. The results of this dynamic test procedure will provide an evaluation of a particular section's performance. If a section's performance is not as specified, then a further reference is made to a local troubleshooting chart, where a listing of possible component failures is provided. Calibration procedures are described next, followed by performance testing.

Note

It is recommended that only personnel with experience in the maintenance of equipment using semiconductor devices be permitted to repair the DCR. It is further recommended that these personnel study Section V before attempting such repair.

6-4. TESTING.

6-5. The next few paragraphs outline the procedures for dynamic testing of the unit's major sections. The tests are ordered as follows: control-circuit voltage regulation, voltage-mode section and current-mode section. It is recommended that, whenever testing is done, this order be maintained.

Note

If components such as unijunction transistors Q17, Q19 and Q21 or components from the differential amplifiers are replaced, recalibration may be required. Refer to para 6-9.

6-6. CONTROL-CIRCUIT VOLTAGE REGULATION. To test the voltage-regulation section proceed as follows:

a. Remove unijunction transistor Q17, Q19 and Q21 . Power circuit is, in effect, disabled. Mark each transistor so that, when reinserting, transistor may be returned to socket from which removed.

b. Connect a 0-50 Vdc voltmeter across capacitor C10.

c. Apply nominal three-phase input to terminal board TB1 and close unit circuit breaker. Power is applied to voltage regulator through transformer. Voltmeter should indicate 20.0 $\pm$ 0.1 V. If it does not, attempt to adjust using potentiometer R20. "Glyptal " R20 after adjustment.

d. Vary input voltage through entire range (refer to Table 1-1 for unit specifications). Regulation should be 2 mV or better.

e. If regulation does not perform as specified above, refer to Table 6-2 for troubleshooting. Terminate procedure by setting unit circuit breaker to OFF, and reinserting transistors Q17, Q19 and Q21 in their respective sockets.

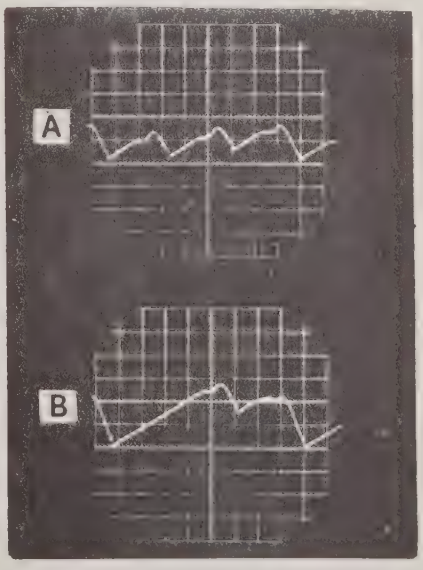


Figure 6-1. No-load Output Ripple
(a) normal
(b) firing circuit failure (1 V/cm vertical; 2 msec/cm horizontal)

SYMPTOM	TROUBLE
Nc Output	a. Check input.
	b. Unit circuit breaker tripped. (Check power circuit, diode CR23 and transistor Q15 if breaker continues to trip after repetitive resetting).
	c. Thermal overload circuit operative. THERMAL OVERLOAD indicator glows. Check for a defective thermostat. Check each cooling fan input voltage with a 120 V AC voltmeter. Voltage should be 115 ± 5 V AC.
	d. Failure in control-circuit voltage regulator. Refer to para 6-6.
	e. Defect in voltage-mode section. Test section per para 6-7.
	f. Current-mode section failure. Refer to para 6-8.
High Voltage Output	a. Failure in control circuit regulator. Refer to para 6-6.
	b. Failure in voltage-mode section. Refer to para 6-7.
High Output Current (No Limiting)	First test control circuit regulator and voltage mode section (para 6-6 and 6-7, respectively); then check current mode section per para 6-8.
Low Output	a. Check input. See Table 1-1 for input specifications.
	b. Faulty control-circuit voltage regulator. Test per para 6-6.
	c. Failure in voltage-mode section. Refer to para 6-7.
	d. Defective current-mode section. Test per para 6-8.
	e. Silicon controlled rectifier open, or defective firing circuit. See Figure 6-1 for oscilloscope patterns of both normal ripple at no load and ripple with a faulty firing circuit.
No Output	a. Input phase failed.
PHASE FAILURE Light Glows	b. Open CR31, CR32 or CR33.
	c. Shorted CR16 or CR17.

Table 6-1. General Troubleshooting

SYMPTOM	TROUBLE
Regulator Output about 12 V.	a. Transistors Q1, Q2, Q4 or Q5 open. b. Transistor Q3 or Q6 shorted. c. Potentiometer R20 defective (negative side open). d. Diode CR20 shorted. e. Check input to regulator by connecting an oscilloscope (0.5 V/cm, 1 msec/cm) and a 0 - 50 volt DC voltmeter across capacitor C9. Ripple should be about 1.2 volts and voltage should be about 42 volts.
Regulator Output about 30 V.	a. Defective R20 (wiper open or positive side open). b. Transistor Q3 open. c. Diode CR20 open. d. Shorted transistor Q2, Q4, or Q5. e. Diode CR18 or CR19 open.

Table 6-2. Voltage Regulator Troubleshooting.

6-7. VOLTAGE-MODE SECTION. To test the voltage-mode section, proceed as follows:

a. Remove unijunction transistors Q17, Q19 and Q21 . This effectively disables the power circuit. To insure that each transistor will be returned to the socket from which it was removed, mark each for identification. Remove transistor Q10 .

Note

Shorting in power-circuit components may result in continued output. Check before proceeding.

b. Short the output terminals. The 20 volt regulator output will then appear across the beta network (R51 and R52).

c. Connect an oscilloscope across capacitor C21. Set vertical sweep to 5 V/cm; horizontal to 5 msec/cm.

d. Set COARSE and FINE VOLTAGE controls fully counterclockwise and CUR.ADJ.AMPS control to about 4 A.

e. Apply nominal input and close unit circuit breaker. The control-circuit voltage regulator will function on power supplied by transformer T4 .

f. Observe oscilloscope. A single horizontal line should be displayed. If a square wave pattern develops, it is indicative of high unit output voltage. Refer to Table 6-3.

g. Rotate FINE VOLTAGE ADJUST control a few degrees clockwise and observe oscilloscope. Repeat procedure until a sawtooth pattern appears on oscilloscope. The rise time of the sawtooth should be controllable by slight rotation of FINE VOLTAGE ADJUST.

Note

Lag time between rotation of control and unit response (as indicated on oscilloscope) is 5 to 10 seconds. A change of oscilloscope patterns from straight line to square-wave without a sawtooth is an indication that the increments of control rotation were too great. Repeat "g" using a smaller degree of turning.

SYMPTOM	TROUBLE
No Unit Output. Straight line display on oscilloscope (refer to para 6-7).	a. Transistor Q13, Q14 or Q9 shorted. b. Potentiometer R39 open. c. Transistor Q11 or Q12 open. d. Transistor Q13 open. Initial symptom: output voltmeter pointer pegs, then output drops to zero. e. Transistor Q12 shorted. See "d" for initial symptom.
High Unit Output. Square wave display on oscilloscope (refer to para 6-7).	a. Potentiometer R41, R42 or R43 open. b. Transistor Q11 shorted. c. Transistor Q9 open. d. Potentiometer R43 wiper open.
Unit Output goes to maximum; COARSE VOLTAGE ADJUST has no effect.	Potentiometer R41 wiper open.
Low Output Voltage	Diode CR24 open.

Table 6-3. Voltage-Mode Section Troubleshooting

h. The above procedures checked the voltage-mode section and a portion of the firing circuit (transistor Q16, diode CR28 and capacitor C21). Repeat entire procedure with the oscilloscope across capacitor C22 and then across capacitor C23. This will check a portion (Q18, CR29, C22 and Q20, CR30, C23) of each of the other two firing circuits.

Note

Inability to achieve a sawtooth across any of the capacitors is an indication of a voltage-mode section failure (refer to Table 6-3); lack of a sawtooth across a single capacitor is indicative of a failure in the firing circuit.

j. Terminate test by opening unit circuit breaker, removing short from output terminals and replacing transistors Q17, Q19 and Q21 in their respective sockets. Reinsert transistor Q10.

6-8. CURRENT-MODE SECTION. If tests of both the voltage regulator and voltage-mode sections show that these sections are operating properly, proceed as follows to test current-mode operation:

a. Turn FINE and COARSE VOLTAGE ADJUST and CUR.ADJ.AMPS controls fully counterclockwise.

b. Connect a 0 - 1 volt dc voltmeter across the unit output terminals.

c. Make certain properly sequenced three-phase input is available and then set unit circuit breaker to ON.

d. Rotate FINE VOLTAGE ADJUST control until 0.4 volt is indicated on test voltmeter.

e. Open circuit breaker and disconnect test voltmeter. Connect about a two-foot length of No. 20 wire across output terminals.

f. Close unit circuit breaker. CURRENT MODE indicator will glow.

g. In steps using small increments, rotate CUR.ADJ.AMPS to 7.5 A while observing ammeter. Ammeter should read output equal to that set on control.

h. If unit does not function as specified above, refer to Table 6-4.

i. Terminate test by setting unit circuit

SYMPTOM	TROUBLE
No Output: CURRENT MODE Indicator Glows (refer to para 6-8)	a. Diode CR22 shorted. b. Potentiometer R25 defective, check wiper. c. Diode CR23 shorted.
Over-current: CURRENT MODE Indicator glows. (refer to para 6-8)	a. Diode CR22 open. b. Potentiometer R24 open.
Over-current: no indication from CURRENT MODE light	a. Transistor Q8 shorted. b. Transistor Q10 open.
No Current Output, no indication from CURRENT MODE light	a. Transistor Q8 open. b. Transistor Q10 shorted.
Ammeter indicates maximum output; CURRENT MODE indicator glows; CUR.ADJ.AMPS has no effect.	Defective wiper on potentiometer R24.
Current lower than that set on CUR.ADJ. AMPS control (refer to para 6-8); CURRENT MODE light glows	Transistor Q15 shorted
Unit current limiting; no light indication	a. Burned out lamp. b. Open transistor Q15.

Table 6-4. Current-Mode Section Troubleshooting.

breaker to OFF and by removing terminal shorting wire.

6-9. CALIBRATION.

6-10. The following paragraphs delineate the steps to be followed for complete unit calibration.

6-11. CONTROL-CIRCUIT VOLTAGE REGULATOR. Procedures to calibrate the voltage regulator are identical to those listed under para 6-6.

6-12. VOLTAGE-PROGRAMMING CURRENT. To make the programming current calibration, proceed as follows:

a. Remove unijunction transistors Q17, Q19 and Q21 . Mark each for eventual return to socket from which it was removed.

b. Set COARSE and FINE VOLTAGE ADJUST controls fully counterclockwise. Rotate CUR. ADJ.AMPS control fully clockwise.

c. Connect a milliammeter (0-10 mA range) in series with potentiometer R41 (COARSE VOLTAGE ADJUST). Use clip-on type meter, if available.

d. Apply properly sequenced three-phase input and close unit circuit breaker. Test ammeter should indicate approximately 2 mA. Adjust potentiometer R39 to obtain specified indication.

e. Set unit circuit breaker to OFF and remove ammeter from reference circuit.

f. Insert each unijunction transistor Q17, Q19 and Q21 into its respective socket.

6-13. OUTPUT VOLTAGE. With unit hooked up to a properly sequenced three-phase input, proceed as follows to calibrate unit voltage output:

a. Close unit circuit breaker.

b. Rotate COARSE VOLTAGE ADJUST control

to obtain a 300 volt no-load output.

c. Connect an oscilloscope (0.5 V/cm, 10 msec/cm) across output terminals.

d. Apply full load and observe oscilloscope pattern. Position horizontal axis so that a comparison between the peaks may be made. Peaks should be adjusted so that all are balanced within .320 to 1.2 V horizontal band. Use potentiometer R60, R63 and R66.

e. Disconnect oscilloscope and load.

f. Rotate COARSE VOLTAGE ADJUST control fully clockwise. Unit output meter should indicate 600 V. If it does not, adjust potentiometer R39 until output voltage is 600 V.

g. Turn COARSE and FINE ADJUST controls fully counterclockwise.

h. Connect a differential voltmeter across output terminals. Test voltmeter should indicate 0 ± .4 V. If it does not, adjust potentiometer R43 to bring output to specified value.

i. Disconnect test voltmeter and turn COARSE VOLTAGE ADJUST control fully clockwise. If unit voltmeter does not indicate 600 V; readjust potentiometer R39. Repeat "h" and "i" until all values are as specified.

j. Set unit circuit breaker to OFF.

6-14. CURRENT LIMITING. To perform current limiting calibration, proceed as follows:

a. Connect a 0.001 ohm, 10 watt resistor across output terminals.

b. Set COARSE VOLTAGE ADJUST and CUR.ADJ.AMPS controls fully counterclockwise.

c. Rotate FINE VOLTAGE ADJUST control fully clockwise.

d. Connect a differential voltmeter across the 0.001 ohm resistor.

e. Set unit circuit breaker to ON.

f. Rotate CUR.ADJ.AMPS control fully clockwise. Test voltmeter should indicate .024 V ± .4 mV. If it does not, adjust using potentiometer R25.

g. Rotate CUR.ADJ.AMPS control fully counterclockwise. Voltmeter should indicate 0 ± .4 mV. Adjust potentiometer R23 if necessary to bring voltage to within range specified. Repeat step "f" and "g" in sequence until all values are as specified.

h. Set unit circuit breaker to OFF. Remove voltmeter and resistor from across output terminals.

6-15. GAIN ADJUST. To calibrate the gain, proceed as follows:

a. Rotate COARSE VOLTAGE ADJUST and CUR.ADJ.AMPS completely clockwise. Adjust potentiometers R60, R63 and R66 almost fully clockwise.

Note

Setting potentiometers R60, R63 and R66 fully clockwise will cause the output to collapse. Rotate slightly counterclockwise if this occurs.

b. Reduce input voltage to low end of input specification. Refer to Table 1-1.

c. Balance potentiometers R60, R63 and R66 per para 6-13, steps a-d.

d. Check no-load to full-load regulation. Regulation should be between 400 and 800 mV.

e. Readjust R60, R63 and R66 to obtain a load regulation between 400 and 800 mV. Use R60 as the gain adjust and R63 and R66 as the balancing potentiometers. Final resistance readings of R60, R63 and R66 must be between 700 and 1500 ohms.

f. Rebalance ripple voltage per para 6-13, steps a-d. "Glyptal" resistors R60, R63 and R66.

6-16. PERFORMANCE TESTING.

6-17. The following paragraphs outline checks on unit output that may be performed following unit calibration.

6-18. REGULATION AND RIPPLE. Proceed as follows to test line regulation and output ripple following a unit calibration.

a. Apply three-phase low-line voltage to input terminals. Refer to Table 1-1 for input line specifications.

b. Connect an oscilloscope across output terminals.

c. Turn COARSE VOLTAGE ADJUST control fully clockwise; set CUR.ADJ.AMPS control to right-hand stop.

d. Close unit circuit breaker.

e. Set unit output to 600 V.

f. While slowly increasing input voltage, apply load in small increments until input voltage is at high line and current output is at 19.8 A. Regulation should be 600 mV and ripple less than or equal to 1.68 V.

g. Set unit circuit breaker to OFF. Disconnect oscilloscope.

6-19. TRANSIENT RESPONSE. Test transient response as follows:

a. Rotate CUR.ADJ.AMPS control fully clockwise.

b. Set unit circuit breaker to ON.

c. Connect an oscilloscope across output terminals.

d. Set unit output to 600 V.

e. Apply half load then apply full load. Then go from full load to half load. Maximum output deviation should be 40 volts (typical) and return to steady state (594 to 606 V) should occur in 40 msec.

f. Set unit circuit breaker to OFF and disconnect oscilloscope.

6-20. CURRENT REGULATION. To check unit current regulation, proceed as follows:

a. Connect a differential voltmeter across resistor R56.

b. Set CUR.ADJ.AMPS control to 5

c. Apply a 10 A load to unit.

d. Set unit circuit breaker to ON. Differential voltmeter should indicate between 8.6 and 9.0 V. If it does not, adjust using potentiometer R57 . Note output voltage.

e. Set unit circuit breaker to OFF and short circuit the load.

f. Set unit circuit breaker to ON, and rotate CUR.ADJ.AMPS control until output ammeter indicates 19.8 A.

g. Remove short circuit and adjust load to return output voltage to that noted in step "d".

h. Set unit circuit breaker to OFF and connect a 0.001 ohm, 10 watt resistor in series with the load. Connect the differential voltmeter across the resistor.

i. Short circuit the load. Differential voltmeter reading should not change more than 0.06 mV.

j. Set unit circuit breaker to OFF and disconnect test voltmeter.

Note

"Glyptal" potentiometers R25, R39, R43, R20, R23, and R57.

6-21. THERMAL OVERLOAD. With a 600 volt, no load output, short a set of thermostat terminals. Output should go to zero and THERMAL OVERLOAD indicator should glow. Repeat procedure for each of the other two thermostats.

6-22. PHASE FAILURE. With a 600 volt, no-load output, disconnect an input line. Output drops to zero and PHASE FAILURE indicator glows. Reconnect input line, then repeat test for each of the other two lines.

6-23. PERIODIC SERVICING.

6-24. Periodic servicing of the unit entails only the lubrication of the cooling fans at spot indicated on rotor end face. The intervals at which the fans are to be oiled are a function of both the unit's duty cycle and the ambient temperature. If the unit is operated continuously in high ambients, the fans should be lubricated every 6 months. If, on the other hand, the unit is operated intermittently at room temperatures (20 to 25°C) or below, lubrication need only take place at 12 month periods. For operating conditions between the two duty and temperature extremes, select an interval between 6 and 12 months. The lubricant recommended by Rotron Manufacturing Company, Woodstock, N.Y. is supplied in kit form and may be purchased under Rotron part number 19263.

SECTION VII
REPLACEMENT PARTS LIST

7-1. GENERAL.

7-2. This section provides a replacement parts list for the DCR 600-18A power supply. The list is keyed to the schematic diagram.

7-3. MANUFACTURER CODING.

7-4. The column headed MANUFACTURER CODE contains a listing of letter designators which, when applied to the tabulation that follows, will give the manufacturer from whom a particular item may be purchased. If no manufacturer's part number is listed in the MANUFACTURER PART NO. column, the part may be ordered from the indicated manufacturer by using the Sorensen part number and a complete description of the item.

AB	Allen Bradley Company
AC	Allied Control Co., Inc.
AM	Ammon Instruments, Inc.
AX	Aerovox Corp.
CB	Centralab, Div.of Globe Union,Inc.
CD	Cornell-Dubilier Electronics
CS	Clarostat Manufacturing Co.,Inc.
FC	Fairchild Semiconductor
GE	General Electric Co.
HA	Hughes Aircraft Co.
HM	Heinemann Electric Co.
IRC	International Resistance Co.
MA	Motorola Semiconductor Products
RCA	Radio Corporation of America
RDM	Radio Material Co., Div. of P.R.Mallory
RN	Rotron Manufacturing Company
RS	Raytheon Co., Sorensen Operation
SC	Semicon, Inc.
SE	Seacor, Inc.
SG	Sage Electronics Corporation
SP	Sprague Electric Company
ST	Solitron Devices, Incorporated
STI	Sarkes Tarzian, Inc.
TI	Texas Instruments
WH	Westinghouse Electric Corp.
WL	Ward Leonard Electric Co.

7-5 ORDERING PARTS

7-6. When ordering parts from Raytheon Co., Sorensen Operation, include manufacturer's part number, the Raytheon part number and the unit model number. Address orders to:

Raytheon Company
Sorensen Power Supplies
676 Island Pond Road
Manchester, N.H. 03103

REF DES.	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER PART NUMBER	MFR CODE
B1,2,3,4	Fan, Muffin	91-1000-2		RN
C1,3,5	Cap., 68 nF, 1000 Vdc	24-2111-12		CD
C2,4,6,43	Cap., 100 nF, 200 Vdc	24-2409-13		AX
C7 (A-D)	Cap., 1.7 mF, 300 Vdc	24-2470-3		SP
C8,31,32,33, 34,35,36	Cap., 20 nF, 900 Vac	24-026		RDM SP
C9	Cap., 250 µF, 50 Vdc	24-2287-8		SP
C10,19	Cap., 25 µF, 25 Vdc	24-2286-4		SP
C11	Cap., 50 µF, 25 Vdc	24-2286-5		SP
C12	Cap., 50 µF, 15 Vdc	24-2278-13	TE 1160	SP
C13,17	Cap., 100 µF, 15 Vdc	24-2278-15	TE 1162	SP
C15	Cap., 35 µF, 25 Vdc	24-2279-11	TE 1208	SP
C16,20	Cap., 10 nF, 200 Vdc	24-2409-7		AX
C18	Cap., 4 µF, 25 Vdc	24-2279-4	TE 1201.2	SP
C21,22,23	Cap., 220 nF, 200 Vdc	24-2409-15		AX
C24,25,26	Cap., 75 µF, 75 Vdc	24-2457-2		SP
C27	Cap., 50 µF, 50 Vdc	24-2280-12	TE 1307	SP
C28,29,30	Cap., 470 nF, 600 Vdc	24-642		SP
C37,38	Cap., 100 nF, 600 Vdc	24-2410-13		AX
C39,40,41	Cap., 2 µF, 660 Vac	24-3905-2		SP
C44	Cap., 10 nF, 50 Vdc	24-2014	CK 103	CB
C45	Cap., 25 µF, 6 Vdc	24-2275-11	TE 1091	SP
CB 1	Circuit Breaker	92-348		HM
CR1,3,5	Rectifier	26-1031	C145P	GE
CR2,4,6	Rectifier	26-1028		WH
CR7,9,11	Rectifier	26-1075-8		STI
CR8,10,12	Rectifier	26-1075-7		STI
CR13,14,15,18, 19,25,26	Rectifier	26-1017	5637/9119	RS
CR16,17,22,23, 34,35,36,37,38	Rectifier	26-158-1		SC
CR20	Diode, Zener	26-211	1N750A	MA
CR24	Diode, Zener	26-223	1N746	HA
CR27	Diode, Zener	26-206	1N753	MA
CR28,29,30	Diode, Zener	26-244	1R20A	ST
CR31,32,33	Rectifier	26-158-2		SC
DS1	Lamp	42-315		GE
DS2	Lamp	42-341	1302	GE
DS3	Lamp	42-301		GE
DS4	Lamp	42-344	1815	GE
K1,2	Relay	92-924		AC

Table7-1. Replacement Parts List - Model DCR 600-18A Three Phase (Sheet 1 of 3)

REF DES.	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER PART NUMBER	MFR CODE
L1,2,3	Choke	127-1754		RS
L4	Choke	127-1808		RS
M1	Ammeter, 0-20 A	94-433-5		AM
M2	Voltmeter, 0-800 V	94-549-18		AM
Q1	Transistor, PNP	18-146		RS
Q2	Transistor, NPN	18-142	40312	RCA
Q3,4,5, 6,14	Transistor, NPN	18-144		FC
Q7,8,9, 10,11,16, 18,20	Transistor, PNP	18-143		FC
Q12,13	Transistor, NPN	18-125-2		GE
Q15	Transistor, NPN	18-161-5*		
Q17,19,21	Transistor, Unijunction	18-153	2N2647	GE
R1,2,3 (A-B)	Resistor, .16 Ω, 175 W	27-1071		WL
R4,6,8	Resistor, 33 Ω, 2 W	27-335	HB 3301	AB
R10 (A-D)	Resistor, 1.5k Ω, 100 W	27-1030		WL
R11 (A-D)	Resistor, 250 Ω, 100 W	27-831	100F250	WL
R13	Resistor Assembly	190-3867		RS
R14	Resistor, 100 Ω, 1/2 W	27-173	EB 1011	AB
R15	Resistor, 680 Ω, 2 W	27-360	HB 6811	AB
R16	Resistor, 1.2k Ω, ±5%,1/2 W	27-150	EB 1225	AB
R17,18,19, 29,38	Resistor, 1k Ω, 1/2 W	27-103	EB 1021	AB
R20	Potentiometer, 1k Ω, 2W	29-406		CS
R21	Resistor, 680Ω, 1/2 W	27-156	EB 6811	AB
R22,47	Resistor,2.2k Ω, 1/2 W	27-152	EB 2221	AB
R23	Potentiometer, 500 Ω, ±20%, 2 W	29-450		CS
R24,42	Potentiometer, 150 Ω, 2 W	29-391		CS
R25	Potentiometer, 10k Ω, 2 W	29-493		CS
R26	Resistor, 3.92 kΩ,±1%, 1/2 W	28-1145		IRC
R27	Resistor, 221 Ω, ±1%, 1/2 W	28-1188		IRC
R30,45	Resistor, 4.7k Ω, 1/2 W	27-107	EB 4721	AB
R31	Resistor, 681 Ω,±1%, 1/4 W	28-1224		IRC
R32	Resistor, 332 Ω, ±1%, 1/4 W	28-1223		IRC
R33	Resistor, 10k Ω, ±1%, 1/4 W	28-1226		IRC
R34,36,37	Resistor, 330 Ω, 1/2 W	27-102	EB 3311	AB
R35,44	Resistor, 470 Ω, 1/2 W	27-166	EB 4711	AB
R39	Potentiometer, 2k Ω, 2 W	29-407		CS
R40	Resistor, 475 Ω, ±1%, 1/4 W	28-1166		IRC

Note: Resistor tolerance is ±10% unless otherwise specified.
* Selected part.

Table 7-1. Replacement Parts List - Model DCR 600-18A Three Phase (sheet 2 of 3)

REF DES.	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER PART NUMBER	MFR CODE
R41	Potentiometer, 3k Ω, 2 W	29-408		CS
R43	Potentiometer, 150 Ω, 2 W	29-531		CS
R46	Resistor, 68k Ω, 1/2 W	27-143	EB 6831	AB
R48	Resistor, 6.8k Ω, 1/2 W	27-185	EB 6821	AB
R49	Resistor, 182 Ω, ±1%, 1/4 W	28-1222		IRC
R50	Resistor, 2.7k Ω, 1/2 W	27-174	EB 2721	AB
R51	Resistor, 60k Ω, ±5%, 8 W	28-1288		SG
R52	Resistor, 900 Ω, ±5%, 3 W	28 1153	1400S900-5	SG
R53	Resistor, 2k Ω, ±1%, 1/4 W	28-1225		IRC
R54	Resistor, 121 Ω, ±1%, 1/4 W	28-1221		IRC
R55,71	Resistor, 5.1k Ω, ±5%, 2 W	27-344	HB 5125	AB
R56	Resistor, 220 Ω, 1 W	27-205	GB 8221	AB
R57	Potentiometer, 50 Ω, ±20%, 2 W	29-467		IRC
R58	Resistor, 22 Ω, 1/2 W	27-153	EB 2201	AB
R59,62,65	Resistor, 6.8k Ω, ±5%, 3 W	27-398-18		WL
R60,63,66	Potentiometer, 2k Ω, 2 W	29-494		CS
R61,64,67	Resistor, 390Ω, 1/2 W	27-1109	EB 3911	AB
R68,69,70	Resistor, 3.3k Ω, ±5%, 3 W	27-398-10		WL
R73	Resistor, .3 Ω, 160 W	27-1064		WL
S1,4	Thermostat	91-1286		TI
S3	Thermostat	92-510		TI
T1,2,3	Transformer, Rect.Input	126-3033		RS
T4	Transformer, Control	126-2856		RS
T5	Transformer, Fan	126-2855		RS
T6,7,8	Transformer, Pulse	126-2632		RS

Note: Resistor tolerance is ±10% unless otherwise specified.

Table 7-1. Replacement Parts List - Model DCR 600-18A Three Phase (sheet 3 of 3)

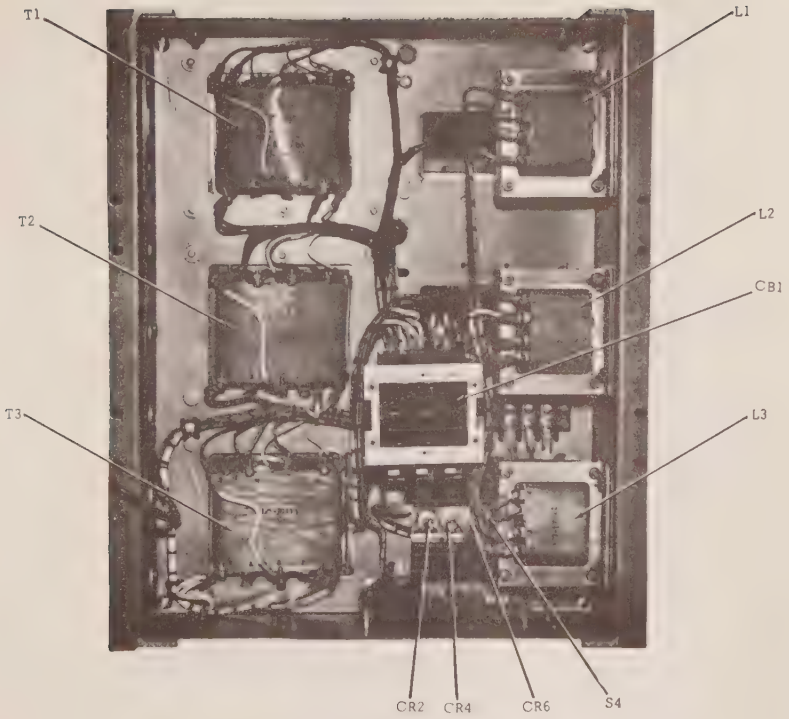


Figure 7-1A. Front View, Panel Removed

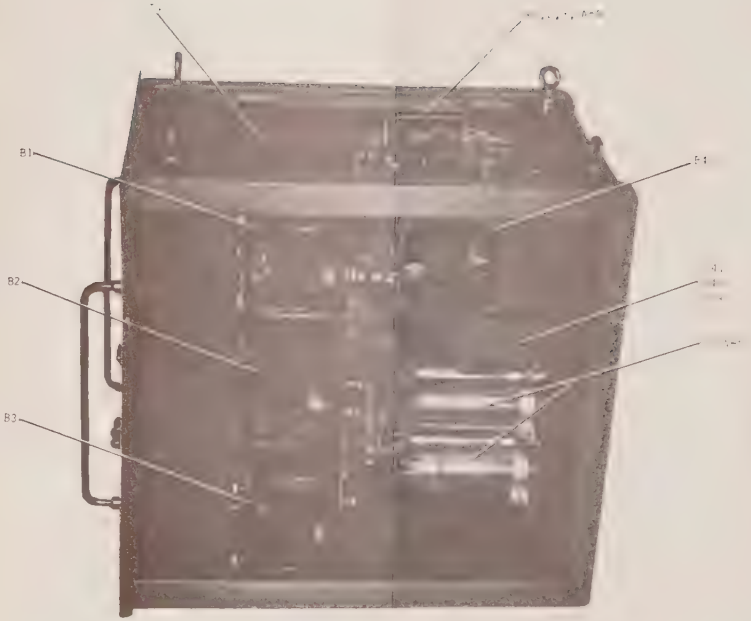


Figure 7-1B. Right-Hand Side, Panel Removed

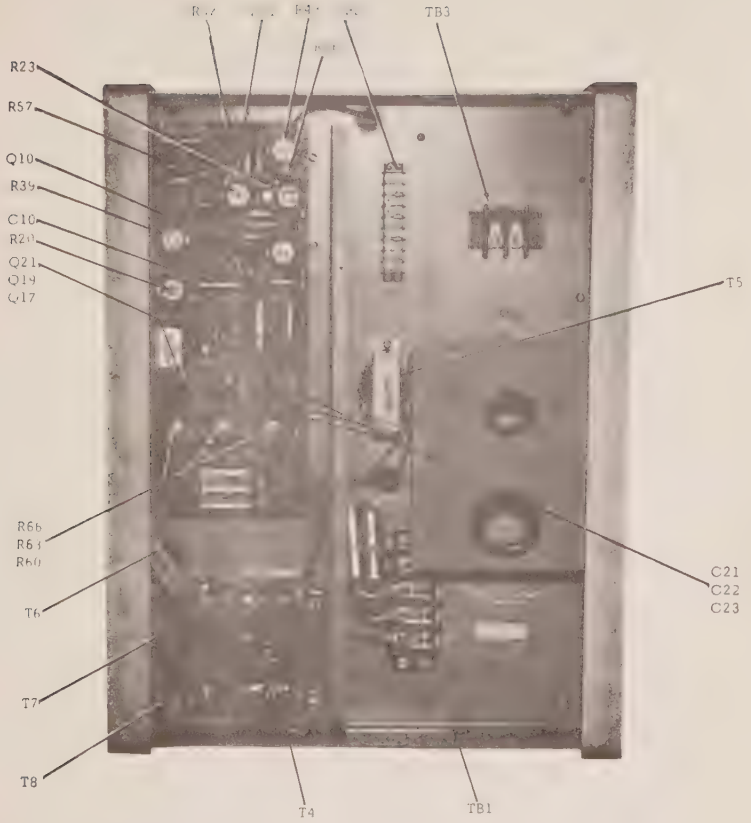


Figure 7-1C. Rear View, Panels Removed

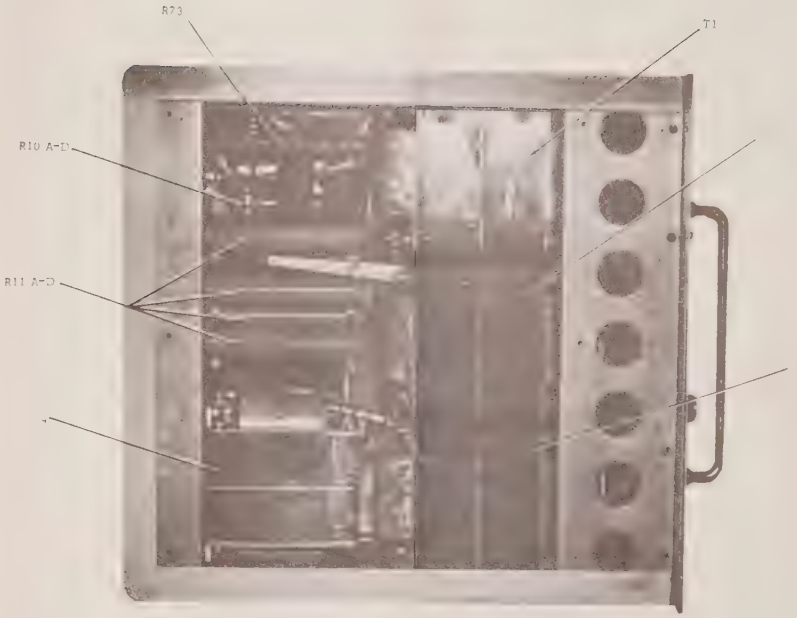


Figure 7-1D. Left-Hand View, Panel Removed

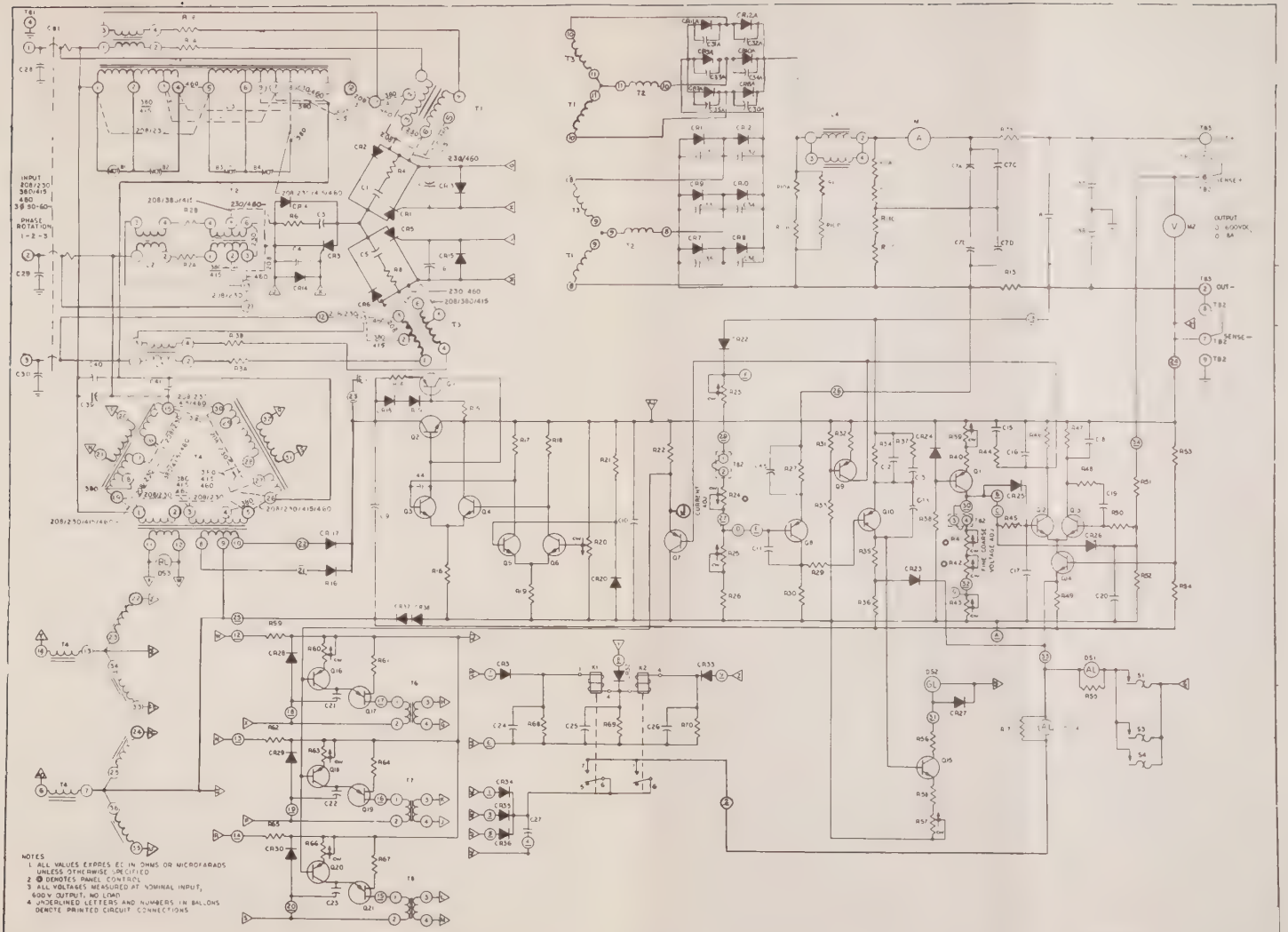


FIGURE 7-2. UNIT SCHEMATIC - MODEL DCR 600-18A

SECTION VIII

OVERVOLTAGE PROTECTOR

8-1. OVERVOLTAGE PROTECTOR. The DCR is available with a factory installed overvoltage protector which prevents damage to the load at a user-selected maximum voltage. The applied voltage range is 10-660 V, crowbar voltage is 2.5 V maximum. Typical loading is 25 mA, response time 10 µsec, temperature coefficient -0.05%/°C, and ambient temperature 70°C maximum.

8-2. Potentiometer R6 in series with differential amplifier Q1-Q2 (with a balance bridge) is across the DCR output and the setting of R6 determines the overvoltage trip point. With applied voltage less than the trip point, Q1 is conducting and Q2 is cut off. As the DCR voltage approaches the trip point, Q1 gradually cuts off and Q2 conducts developing a signal across resistor R2 which fires rectifiers CR4 and CR5; a voltage is developed on resistor R8 providing a gate signal to rectifier CR2 which then short circuits the DCR output. On-off re-cycling of CR2 during current-limit operation is prevented by a connection through the DCR Q7 stage that drops the output to zero. The overvoltage protector also has a circuit connected to one phase of the three-phase circuit breakers on the DCR input, and is activated by CR4 through R8 to trigger rectifier CR11 which then opens the DCR input. Thermostat S1 is a redundant safety feature which will protect CR2 if its temperature rise becomes excessive.

8-3. To adjust the trip level:

a. Turn adjustment potentiometer R6 completely clockwise.

b. Apply power and set the power supply output voltage to the desired trip level.

c. Slowly rotate VP adjustment potentiometer R6 counterclockwise until the output voltage drops.

d. Remove input power and reduce the DCR power supply output voltage setting.

e. Apply power and adjust the DCR power supply control to the desired operating level. The overvoltage protector is now set to lower the output should the voltage reach the trip level set in step "b".

Note

Because of the protector's rapid response, peak voltage disturbances due to line or load change, while undamaging to the load may occasionally cause false triggering. Should false triggering occur, the response time may be slowed down by adding capacitance to C1 and adding capacitance in parallel with R2.

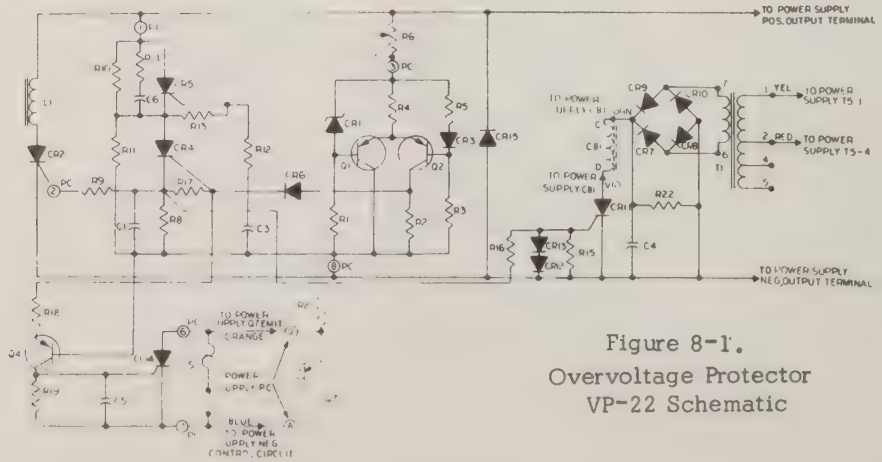


Figure 8-1.
Overvoltage Protector
VP-22 Schematic

REF DES.	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER PART NUMBER	MFR* CODE
C1,5	Cap., .01 μF, 250 V	24-2015-1		SE
C3	Cap., .15 μF, 250 V	24-2015-15		SE
C4	Cap., 32 μF, 150 V	24-2571-3		SP
C6 A,B	Cap., .05 μF, 500 V	24-2010		CB
CR1	Zener Diode	26-258	1N5221B	MA
CR2	Rectifier	26-1103-7		GE
CR3	Rectifier	26-1017	5637/9119	RT
CR4,5	Rectifier	26-1112-1		GE
CR6	Rectifier	26-158-3		SC
CR7-10, 12,13	Rectifier	26-158-2		SC
CR11	Rectifier	26-1113		GE
CR14	Rectifier	26-1052		GE
CR15	Rectifier	26-1078-10		STI
L1	Choke Assembly	127-1824		RS
Q1,2,4	Transistor, PNP	18-143		FC
R1	Res., 178 ohm, ±1%, 1/8 W	28-1283		IRC
R2	Res., 1.8k ohm, 1/4 W	27-1306	CB 1821	AB
R3	Res., 280 ohm, ±1%, 1/8 W	28-1284		IRC
R4,13, 17,18	Res., 1k ohm, 1/4 W	27-1305	CB 1021	AB
R5	Res., 375 ohm, ±1%, 1/8 W	28-1285		IRC
R6	Pot., 75 ohm, 10 W	29-557		CS
R7	Res., 18k ohm, 1/4 W	27-1314	CB 1831	AB
R8,15	Res., 1k ohm, 1/2 W	27-103	EB 1C21	AB
R9	Res., 100 ohm, 1/2 W	27-173	EB 1011	AB
R10,11	Res., 30k ohm, ±5%, 3 W	27-398-24		WL
R12	Res., 68 ohm, 1/4 W	27-1300	CB 6801	AB
R14	Res., 2.7 ohm, 1/2 W	27-1185	EB 27G1	AB
R16	Res., 1.8k ohm, 1/2 W	27-176	EB 1821	AB
R19	Res., 3.9k ohm, 1/4 W	27-1315	CB 3921	AB
R22	Res., 22k ohm, 2 W	27-307	HB 2231	AB
S1	Thermostat, 15 A, 115 V	92-522		TI
T1	Transformer	126-3072		RS

* See Page 7-1.
Note: All resistor tolerances ±10% unless otherwise specified.

Table 8-1. VP-22 Overvoltage Protector Parts List

Sorensen
POWER SUPPLIES

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